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ABSTRACT

Specifically prepared for the use of Forest Service field-based interpreters of the management, protection, and use of forest and range resources and the associated human, cultural, and natural history found on these lands, this book is the second in a series of six primers on the multiple use of forest and range resources. Following an introduction to fire management, there are 12 main chapters: (1) Fire History, (2) Fire Triangle, (3) Fire Physics, (4) Fire Behavior, (5) Weather, (6) Topography, (7) Fuels, (8) Fire Management, (9) Forest and Range Fire Control, (10) Prescribed Fire, (11) Fire Management Research and the Future, and (12) The Need for Fire Management. Also included are a list of 99 facts of interest about fire and fire management and a list of references for suggested additional reading. Forest interpretation is defined briefly (a communications program which offers a service to the visitor through opportunities for on-the-ground guide or "do-it-yourself" learning experiences) and the role of the forest interpreter (usually temporary summer employees--experienced high school or college teachers of the natural sciences) is described. (JT)

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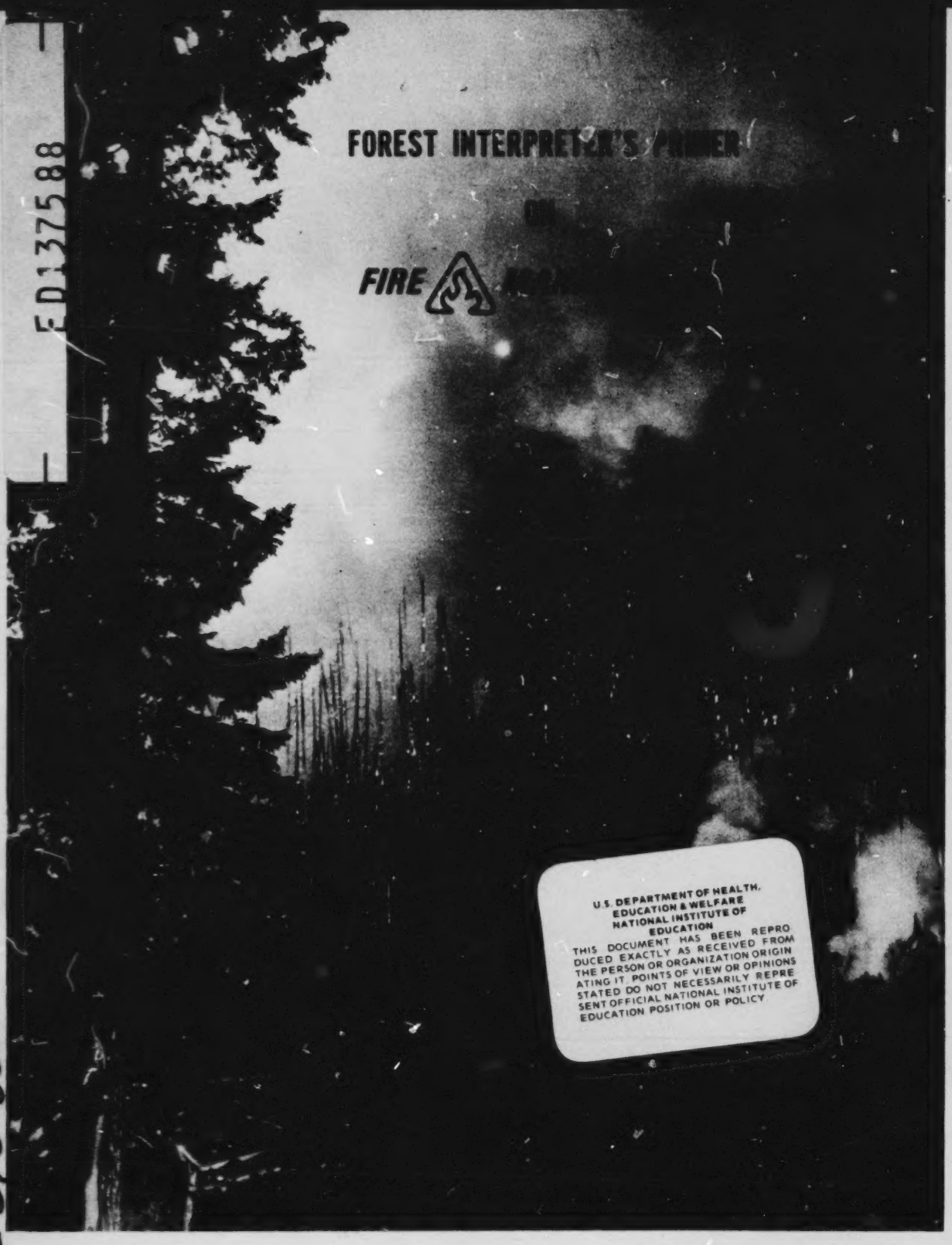

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'76

U.S. FORESTRY
CENTENNIAL

Cover Photo: Ready-made torches.
Willamette National Forest,
Oregon. F-409121

Like candles on a birthday cake,
hundreds of tinder-dry dead snags--
products of a previous fire--glow,
igniting the tender young forest
beneath them. Note the sun--a dim
circular speck in the smokey sky.

CENTENNIAL OF FEDERAL FORESTRY

As our Nation celebrates the Bicentennial of its Independence, it should be noted that 1976 also marks 100 years of Federal forestry in America.

The year 1876 found the United States without a single professionally trained U.S. born forester. There were no schools of forestry and no State or Federal forestry organizations. The practice of forestry was virtually unknown in the United States at that time. This was a period of rampaging forest fires and destructive logging, and the Nation was beginning to show evidence of uneasiness and concern about the future of its forest resources.

In 1876, Congress passed an Agriculture Appropriations bill which had a "rider" authorizing the U.S. Department of Agriculture to study, collect and distribute forestry statistics and information. To direct and perform this work Commissioner of Agriculture, Frederick Watts, appointed Dr. Franklin B. Hough, of Lowville, New York; professionally trained doctor of medicine, self-taught botanist, geologist, climotologist, meteorologist, demographer, economist, statistician, educator, and early day "forester." As a "special agent," he was to nurture forestry for the next 9 years in the U.S. Department of Agriculture and in the Nation. Dr. Hough's job was to "determine annual lumber consumption, the influences of forests upon climate, the sufficiency of wood supply for future needs and forestry methods applicable to the United States' effort to preserve, restore and plant forests." To pay for the first year of this awesome one-man task, Congress provided $2,000.

Dr. Hough set out on his job with great enthusiasm and diligence. By the time of his death in 1885 he had produced or had a large part in four "Reports on Forestry" totaling 2007 pages. He had also written a book on "Elements of Forestry," in 1882. The "reports" are replete with fascinating facts and statistics of that time about numerous aspects of forestry, forest products, destructive forest fires, insects and diseases; and forest products exports. Threading through these volumes is a common sub-theme--an uneasy awareness that there is trouble in the woods. But there is also a strong feeling of hope that eventually, something big and good is destined to come of it all and, it has! Today, a century later, every State in the Union has a forestry protection and management organization as have the forest land-managing agencies of the Federal Government and the forest land-owning industries.

Fourteen years were to pass before America, in 1890, had its first professionally trained, native born forester. He was Gifford Pinchot of Milford, Pennsylvania, who had studied at the Forestry School at Nancy, France. After 8 years as a forestry consultant on private and government jobs, Pinchot became Chief of the Department of Agriculture's Division of Forestry in 1898, renamed the Bureau of Forestry in 1901. In 1905, the U.S. Forest Service was established, replacing the Bureau of Forestry. Pinchot was named its first Chief. Since Pinchot there have been nine succeeding Forest Service Chiefs, with John R. McGuire currently in that position. Traditionally, the Forest Service has always been led by professionally trained career foresters who have come up through the ranks of the Service.

Today, the profession of forestry, represented by its 21,000-member Society of American Foresters, owes much to Dr. Hough, who through his pioneering efforts and much personal sacrifice helped prepare the foundation for scientific forest protection, management and use in America 100 years ago. It is to Dr. Franklin B. Hough that we dedicate this "Forest Interpreter's Primer on Fire Management."

Protector of the forest. Kootenai National Forest, Montana. F-59304

In the beginning the U.S. Forest Ranger had no motorized transport and few roads and trails. He patrolled his district on horseback. In those days many fires burned for weeks until they ran out of fuel against rock cliffs, rivers and lakes, or until a heavy rain doused them out.

Smokejumpers. Deschutes National Forest. F-509321

Determined, fully trained, and superbly conditioned, these young men, equipped with backup chutes, line up to board the plane that will whisk them over the mountain tops to a back country forest fire burning in an area that might take many hours to reach by foot. The key to forest fire control is to hit the fire promptly, while it is still small.

FOREWORD

This "Forest Interpreter's Primer on Fire Management" was specifically prepared for the use of Forest Service field-based interpreters of the management, protection, and use of forest and range resources and the associated human, cultural, and natural history found on these lands. It is the second in a series of six primers on the multiple use of forest and range resources planned for publication by the Visitor Information Service--the interpretive arm of the Forest Service. These primers will be "working and training tools"--special reference materials for forest interpreters--and are not necessarily designed to be popular publications.

Most Forest Service interpreters are temporary summer employees. They are experienced high school or college teachers of the natural sciences. However, few of them have had the opportunity to major in technical forestry. This primer, therefore, consists of basic fire management information intended to supplement the forest interpreter's knowledge of the subject. While it will not make him or her an expert on fire management, its study will definitely broaden the interpreter's knowledge of it.

As the forest interpreter studies this primer, questions will arise that need answers. He or she is urged to consult with the local district ranger or National Forest fire staff officer. We also invite the interpreter to further self-study by reading some of the publications listed in the back of this primer.

Suggestions for improvement of this publication and contributions to our "Did You Know" section are welcomed by the Forest Service.

Henry W. De Bruin

HENRY W. DeBRUIN
Director of Fire Management
Forest Service, Washington, D. C.

7

WHAT IS FOREST INTERPRETATION?

Forest interpretation is a communications program which offers a service to the visitor (usually a family on a vacation or holiday visit to forest, grassland, or its associated lands) through opportunities for on-the-ground guided or "do-it-yourself" learning experiences. Although forest interpretation is usually associated with outdoor recreation, it is much more than an exercise in the identification of the flora and fauna of the range and forest. It is designed to introduce the visitor to the natural resources as they really are, enabling him to explore, become better informed, and to draw his own conclusions about the management, protection, and use of the forest and range and the associated cultural, human, and natural history of the land.

It is hoped that through such an experience, the visitor will come to the self-realization that man and nature are closely interdependent and that the prudent use, protection, and management of natural resources is important and vital to all life on earth. We also hope that the visitor's exposure to the story behind the trees and range becomes a pleasant, exciting and memorable family learning experience in the great out-of-doors.

WHAT IS A FOREST INTERPRETER?

He or she is a person who has a deep-seated compassion for the big and little things in the forest and on the range and understands their relationship to each other and to man. He or she likes and accepts people as they are. The interpreter also knows that to many people, the challenge of the forest is "what's behind the next tree, the next rock, the next bend in the trail, under that bush or over the next hill."

The interpreter is also aware that some people are totally at home in the woods while others are plagued by a sense of lurking danger. He knows that if, as part of the interpretive experience, he can stimulate the use of the visitor's five senses--seeing, touching, smelling, hearing, and tasting--that the visitor will probably leave with an enduring memory of his trip to the forest.

The interpreter also knows that visitor participation--be it physical or mental--is the true key to a meaningful interpretive experience for the visitor to the outdoors. It is for this reason that the interpreter endeavors to provide the visitor with the opportunity to participate in a series of well-designed interpretive experiences, hinged on discovery and "do-it-yourself," which lead the visitor to a feeling of self-confidence, a sense of accomplishment, satisfaction, enjoyment and finally to a self-realization of the basic truths which govern man's relation with nature.

Forest resource interpretation. Cache National Forest, Utah.
F-49002

Seeing is believing. A Forest Interpreter at work with a 4-H Club group. "You don't have to believe it because I say it. There is the old forest. We're standing in the clearing. Those big trees are the mother trees from which the seed to start the young pines at your feet came in after cutting. Outline a sample plot on the ground and count the young trees. Then draw your own conclusions as to whether or not a new forest is in the process of replacing the old one that has been harvested."

FOREST INTERPRETER'S PRIMER

ON

FIRE MANAGEMENT

A reference for Forest Service, USDA Forest Interpreters

TABLE OF CONTENTS:

	PAGE
Introduction	1
Fire History	3
Fire Triangle	4
Fire Physics	4
Fire Behavior	7
Weather	7
Topography	8
Fuels	9
Fire Management	11
Forest and Range Fire Control	15
Prescribed Fire	37
Fire Management Research and the Future	51
The Need for Fire Management	54
Did You Know?	55
Suggested Additional Reading (back cover-inside)	
About the Forest Service (back cover-outside)	

Prepared for the Forest Service by Thomas M. Zelker, Forestry Summer Intern from SUNY College of Environmental Science and Forestry, Syracuse, New York. Produced under the direction of George Vitas, Leader, Visitor Information Service, Recreation Management Staff; with technical review by Junius O. Baker, Jr., Fire Management Specialist, Forest Service, USDA.

Washington, D.C.
July, 1976

Women holding the line on a Idaho range fire. BLM photo.

Young well-trained female firefighters stubbornly hold their section of a Bureau of Land Management range fire that, unchecked, could have destroyed a great quantity of livestock and wildlife forage.

For decades, women have worked in behind-the-lines support roles on large forest and range fires preparing payrolls, purchasing supplies, cooking, and operating communications and record keeping systems. Women have also served and still serve as fire tower lookouts and fire dispatchers. However, with the recent surge in the number of women students pursuing a professional forestry career in the Nation's colleges, the sight of trained women working side by side, with men on a range or forest fireline is no longer a novelty.

FOREST INTERPRETER'S PRIMER ON FIRE MANAGEMENT

INTRODUCTION

Fire, like other natural forces such as wind or rain, is not an independent entity in the forest. It affects vegetation, wildlife, the air and water; and the complex relationships among the many facets of an ecosystem. Fire cannot be separated from total forest management; it must be managed in conformance with the overall land management objectives of the region. The United States Forest Service does not have a clearly stated definition of fire management although fire is managed on the lands administered by this agency. A simple definition of fire management might be that it is the total integration of protection from wildfire, prescribed fire use, and fire ecology knowledge into multiple use planning and land management. Management of fire is needed to: (1) protect life, property, timber, and other resource values; (2) use fire when it is needed to improve wildfire protection, enhance wildlife habitat, fight insects and disease, and provide a suitable growing environment for many timber species; (3) maintain natural ecosystems in the wilderness.

These three needs determine the types of management that will be used for fire. Fire, where it is not wanted, must be stopped and extinguished; this is referred to as wildfire suppression. Prescribed fire is the planned and professionally managed use of fire under controlled conditions to achieve specific land management objectives. It may be ignited by man or by nature--under both conditions, it is closely controlled to predetermined levels of intensity and within predetermined geographic areas. The use of fire can be very helpful in the management of many ecosystems. Prescribed fire and fire suppression are not contradictory or opposing policies; they both are often used together on the same forest to fulfill the needs of society, optimize resource production, and maintain environmental quality.

Many people and agencies are involved in fire management, and varying aspects of fire management take place throughout the whole United States. The Forest Service administers 187 million acres of federally owned forest and grassland and is charged with the multiple use-sustained yield management of these lands. Another responsibility of this agency is cooperative fire protection with states and private landowners who own 23 million acres of land neighboring the National Forests. The National Park Service manages over 24 million acres of parkland. The Bureau of Land Management administers 474 million acres, mostly in Alaska; and over 55 million acres are in the trust of the Bureau of Indian Affairs. The National Wildlife Refuges, under the care of the Fish and Wildlife Service, comprise about 28 million acres. In total, the Federal Government administers nearly one third of the nation's land. The fire management policies of these agencies have much in common but there are also some differences.

The U.S. Forest Service adopted its first fire policy in 1905. It was aimed at protecting forests from fire. Cooperation for fire control between the States and Federal Government was initiated by the 1911 Week's Law. The Clarke-McNary Act of 1924 furnished financial aid to the States for fire protection. Control of wildfires has been a major policy for all forest land agencies ever since.

In 1933, at the depth of the Great Depression, President Franklin Roosevelt and Congress established the Civilian Conservation Corps (CCC) to help reduce the nation's unemployment and to work on needed conservation projects. "Roosevelt's Tree Army," as it was often called, employed over 2.5 million young men in the period from 1933 to the beginning of World War II. For the first time, enough manpower was available to accomplish many forestry related activities on Federal, State, and private land.

Fire control action was an important aspect of this work--men from the more than 2,000 CCC camps throughout the country were easily mobilized to fight fires. They quickly suppressed many fires and held the acreage burned by wildfires to its lowest level ever. In a typical year, the CCC constructed over 11,400 miles of truck trails, built more than 600 fire lookout towers, and maintained many fuelbreaks and water storage ponds throughout the Depression-crippled United States. These projects were extremely important in forest protection in the 1930's and are still valuable and in use in many areas today. Soon it was also seen that carefully prescribed fire could be useful in certain instances. The Forest Service first used prescribed fire in 1943 in southern forests to reduce fuel accumulations and fight brownspot needle blight on longleaf pines. Prescribed fire is now used extensively throughout the South in resource management. The National Park Service began using prescribed burning in the Everglades of Florida in 1958 to protect the pine savannahs from being overtaken by hardwoods. In 1972, the Forest Service initiated the use of natural prescribed fires in Wilderness Areas. The Fritz Creek Fire in the Selway-Bitteroot Wilderness was the first large fire to burn under close surveillance to maintain natural ecosystems.

Fire in America had run the gamut from natural, Indian, and settler caused fires to devastating post-logging fires. Total fire suppression was the first fire policy of American forest management agencies. Introduction of the wise and beneficial use of fire, in addition to aggressive fire suppression, has changed this policy to one of complete fire management. If fire is wanted by the resource manager, it can be used under carefully predetermined conditions; but it must be suppressed if it goes counter to the land management needs.

State and local governments own more than 28 million acres of commercial forest land. Over 67 million acres are owned by the nation's forest industries, while farmers own more than 131 million acres of productive forest land. Another 167 million acres are owned by other private non-farmer landholders. State and private forests are also managed according to many various policies. Cooperation between the Federal Government and the private sector is vital to the total fire management picture. Over 511 million acres of State and private lands are protected from wildfires through cooperation with State Forestry agencies as provided for in the Clarke-McNary Act of 1924. In all, more than 91 percent of the total forest area in the United States is protected from the threat of wildfire.

FIRE HISTORY

The history of fire in America is a long and dramatic one. Fossil charcoal, indicating the occurrence of ancient fires, has been found in coal deposits that are believed to be over 80 million years old. Charcoal that is many thousands of years old has been discovered in the organic deposits of northern lakes. Natural disturbances, such as fire and windthrow, were common in eastern North America during primeval times; many forest stands of different ages and species mixtures were present, indicating varying stages of succession.

Forest fires were sometimes ignited by North American Indians to clear the woods of undergrowth, facilitating travel and improving visibility for hunting, and to create grassy openings to attract deer. The open, parklike stands of pines in southern New Jersey were the result of natural and Indian-set surface fires. However, the Sheepeater Indians of Montana fought fires that threatened their camps and hunting grounds.

When the colonists arrived, they used fire to clear the land for farming and grazing. Smoke from land-clearing fires was often a welcome sight to travel-weary frontiersmen.

As the nation grew, wood became a more valuable resource. Around the turn of the century, the logging of large areas to supply the lumber needs of society became very common. The logging slash, branches, and small trees that were left on the site became a serious fire hazard. Many catastrophic fires resulted from this and from the careless use of fire. For example, in 1871, the Peshtigo, Wisconsin fire burned over 1.2 million acres and killed 1,500 people; it was the nation's worst fire ever in terms of human casualties. The Great Idaho fires of 1910 started from settler, logging, and railroad fires--they burned 3 million acres and killed 86 people.

FIRE TRIANGLE

Fire is a thermo-chemical reaction that converts chemical energy stored in fuel into heat energy. Light, in the form of a flame, is often produced. In order to have fire, or combustion, three things are needed. They are fuel, oxygen, and heat--together they are called the fire triangle. These three components are needed concurrently for fire to take place; if any one leg of the fire triangle, such as heat, is removed, combustion cannot take place.

The atmosphere is 21 percent oxygen; therefore, oxygen is usually available in sufficient quantities to support fire. However, fire can be smothered and stopped by applying enough soil to it to cut off the oxygen supply.

Fuels are anything burnable from grass and brush to old tree stumps. Sources of heat can be quite varied. Man is a major fire starter--about 90 percent of all wildfires are caused by man. Carelessness, such as dropping burning matches or cigarettes in the forest, burning trash or leaving a campfire, is often responsible for forest fires. The deliberate starting of fires by incendiarists is the main cause of wildfires in some forested areas. Sparks from trains are another important ignition source. Lightning is the major cause of natural fires although spontaneous combustion and occasionally sparks from rockslides are also rare fire starters. One half of all fires occurring on Forest Service protected lands start from lightning strikes. These lands are, for the most part, in the west, mountainous and isolated from habitation. Lightning occurs in thunderstorms when the atmospheric electric fields are altered and intensified, thus causing massive sparks between the cloud and the ground. When the fuels are dry enough, lightning may cause many forest fires in the course of a storm.

FIRE PHYSICS

There are three phases of combustion: (1) preheating, (2) flaming, and (3) glowing. Preheating, or pyrolysis, starts decomposing the wood by means of oxidation intensified by heat. Water and some chemicals are evaporated from the wood in this phase. As the temperature increases, the wood ignites; this is the initiation of combustion. For forest fuels, ignition occurs mostly between 500 and 750 degrees Fahrenheit. In the flaming phase burning is sustained by gases evolved from the heated wood. Temperatures have been measured at 2,600 degrees Fahrenheit in large fires, but temperatures of 1200 to 1500 degrees are more common. Charcoal, unburned wood carbon, is left after this process. Glowing combustion then oxidizes the charcoal to form carbon dioxide, water vapor, and ash, producing no flame during this stage.

The products of complete combustion are ash and gases. Ash is residual (inorganic) material that is composed of many natural minerals such as phosphorus, potassium, and calcium compounds. These nutrients are recycled into the soil after forest fuels are burned. The ash volume produced is less than 1 percent of the original solid wood volume. The gases produced are predominately water vapor and carbon dioxide. Carbon monoxide, organic hydrocarbons, and traces of nitrogen oxides are also produced. Smoke is, for the most part, water vapor condensed on fire particulate matter such as unburned carbon. Small droplets of organic material make up the rest of the smoke plume.

The heat generated by fire can be transferred to other materials by three processes: radiation, convection, and conduction. These processes are important in keeping the present fire burning and in preheating other fuels so they can ignite and spread the fire. Radiation is the transfer of heat through space as exemplified by heat lamps. Convection transfers heat by the movement of hot air--the heating of a room with a forced air heater is accomplished by convection. With conduction, the heat is transferred within solid substances. For example, the heating of an iron bar is accomplished through conduction.

There are three basic forms of fires:

(1) Ground fire - The fire consumes organic material beneath the forest floor. Slow moving, hard to suppress fires in peat beds or bogs are typical of this form of fire.

(2) Surface fire - Here, the fire burns leaves, twigs, and other fuels on the forest floor and low vegetation. Grass fires are surface fires.

(3) Crown fire - This is a fire that burns through the tops of trees, consuming fuels from the ground up to the top of the forest canopy.

Fire storms, or blowup fires, are extreme examples of the combustion process that are very intense and usually uncontrollable. A convection column develops that may be in excess of 40 thousand feet high. This column acts as a chimney for violent updrafts of hot air that may carry flames up hundreds of feet. Updrafts and fire whirlwinds may throw burning embers onto dry fuels miles away from the main fire and thus greatly increase the rate of fire spread. Fire storms occur only under special atmospheric conditions and when there are large amounts of dry fuel available.

"Fuel." Superior National Forest, Minnesota. F-372669

Jackpine slash--wood material that remains after logging--when tinder dry, can be kindled into a raging forest fire. To hasten decomposition and to reduce the fire hazard, slash such as this can be cut into smaller pieces by axemen or chopped and crushed by heavy equipment so that it rests closer to the damp ground to more rapidly decompose and replenish the soil.

Wasted resources and energy. Private forest land, Washington. F-237349

This is not trick photography. The photo is old but the latent power of a hot forest fire which put spaghetti bends into a pair of steel rails still lurks in the woods. This was the product of the intense heat generated by a 1929 fire that burned this trestle and heavy logging slash during a period of extremely dry weather in Washington.

FIRE BEHAVIOR

The behavior of a fire is determined by the environment in which it is burning. Weather, topography, and fuels are the main components of the fire environment.

WEATHER

Fire weather describes the influence of weather on fire behavior. Wind, humidity, and temperature are the three basic factors affecting fire weather. Temperature influences the heating and drying of fuels; higher temperatures bring fuels closer to their ignition point and also decrease the moisture in fuels so burning can occur more quickly at hotter temperatures. Wind supplies large amounts of oxygen to fires, dries fuels through increased evaporation and convection from fires, and largely determines the direction and rate of spread of a fire. Fires usually spread outward in all directions from the ignition point--the rates of spread vary depending on wind speed and direction.

Head fires spread in the same direction as the wind and their rate of spread increases as the wind increases because more oxygen is supplied to the fire and the wind-bent flames preheat fuels faster. Fast and dangerous erratic fire behavior can result when winds are strong and gusty. Back fires, in contrast, move against the wind. Increased wind speed has little affect on these fires except to supply more oxygen to the flames. These fires usually spread at slower, more constant rates of 70 to 200 feet per hour. Flank fires spread at right angles to wind direction.

The drying effects of the winds are most important on small fuels such as leaves and twigs. As the fuels dry, they become easier to ignite. In contrast, high humidity or precipitation have a great effect on fire behavior since wet fuels don't burn as readily as dry ones. The moisture content of fuels must be below a certain level for a fire to burn. The fuel moisture content varies directly with the atmospheric humidity. Often fires stop or slow down at night due to increased humidities and resulting higher fuel moisture contents.

Complex combinations of temperature, wind, and humidity form weather systems that affect large regions of the world. Frontal systems, storms, and air masses affect fires on a large scale by governing the wind, rain, humidity, and temperatures over wide areas. The yearly weather pattern, or climate, largely determines the fire season for a geographic region. This is the season of maximum fire

occurrence in a region; fuels are readily burnable and weather conditions allow fires to spread during this time.

TOPOGRAPHY

Topography is another component of fire behavior. The character or roughness of the land can cause varied rates of fire spread and behavior--air turbulence induced by topography may generate erratic fire behavior.

Differences in elevation produce differences in temperature, wind, rainfall, and types of fuel, all of which affect fire behavior. Steep slopes increase the rate of fire spread uphill due to increased radiation and convection to fuels in front of the fire.

Winds vary on slopes depending on the amount of warming sunshine received--they sweep up the slope when the sun is shining on that slope but blow downslope during cloudy periods and at night. Valley winds are similar but not as dependent on actual sunshine. They blow up the valley during the day and downvalley at night.

The aspect, or the direction in which a slope faces, can be a critical factor in fire behavior. Southwest slopes receive the most sunshine and are therefore hotter, dryer, and consequently more dangerous in terms of fire behavior.

Aspect and elevation also influence the type of vegetation that occurs on different parts of a mountain. In the East, the pines usually grow on the southern aspect while the spruce, fir and hardwoods are generally found on the more shaded, moist, northern slopes. Stunted, slow growing vegetation is often found at higher elevations, especially when the soil is very shallow and rocky. These vegetation types produce different fire behavior patterns and must all be considered in predicting the overall fire behavior.

Fires in coastal areas are affected by land-sea breezes. During the day, winds usually blow from the sea onto the land but at night the direction is normally reversed.

Dry rocky areas, as well as lakes and streams, act as natural firebreaks. These land features often protect forests from fires, but can also serve to funnel fire through certain areas to produce fire-dominated vegetation types. These natural firebreaks are frequently used by firefighters in many fire control activities. In summary, the effects of local winds, elevation, slope, rock and water bodies, and aspect, along with larger weather patterns, greatly influence the behavior of fire and must be taken into account in planning and executing fire control operations.

FUELS

The last major factor of fire behavior is fuel--anything in the forest that will burn. Without fuel, there could be no fire. The size of forest fuels makes a great difference on a fire's rate of spread and ease of control. Small, light fuels, such as dried grass and leaves, are highly flammable and fast burning. Dried branches and twigs that are less than two inches in diameter are also easily ignited and can burn quite intensely. Larger branches and logs require long periods of dry weather before they are burnable but, when dry, they produce hot persistent fires which are difficult to extinguish.

Fuel moisture content is one of the most important and variable factors in a fire. Damp fuels are difficult to ignite while dry fuels ignite quickly and liberate heat rapidly. Normally, the fuel moisture content must be less than 25 percent to get small fires started. Relative humidity has a direct effect on the amount of moisture found in all fuels and is therefore very important in determining fuel characteristics.

The continuity of the fuel bed is a major factor in determining fire behavior. Uniform fuels that are spread out evenly over an area can be fast burning while fuels that are scattered or are patchy tend to slow down the fast rate of spread. Dry continuous fuels from the forest floor up to the tree canopy are like a fuse and are an invitation to crown fires.

The compactness of the fuel also affects the rate of fire spread. Tightly compacted fuels, such as hemlock needles on the ground, may be packed too densely to supply enough oxygen for rapid spread of fire. Large ponderosa pine needles, on the other hand, being loosely packed, burn very quickly since abundant oxygen is available, permitting rapid combustion to take place.

In summary, it can be said that weather, topography, and fuels interact to determine fire behavior. No one factor acts alone in this complex fire environment. Fire managers, and others concerned with fire management, must have an intimate knowledge of fire behavior if fire is to be properly handled in the natural environment.

Active fire. Klamath National Forest, California. F-474617

Topography--steep and inaccessible except by foot or air. Tricky mountain air currents and precipitous slopes call for well trained firefighters with good judgement and a strong appreciation for safe working habits.

Instant weather report. Salmon National Forest, Idaho. F-508479

How fast is the wind blowing? This critical question can be answered by this instrument out of a portable fire weather kit, developed by the U.S. Weather Bureau. The Weather Bureau has a long standing record of cooperation, nationwide, with State, Federal, and private fire protection organizations.

FIRE MANAGEMENT

"Fire management," as used here, is a relatively new term employed to describe the role of specialists who deal with both wildfire (unwanted) and prescribed fire (wanted). Some differences among forest and range fire specialists as to the meaning of "fire management" still persist. However, we believe that Dr. Richard J. Barney, U.S. Forest Service Fire Researcher at Missoula, Montana, states it about as clearly as anyone. He sees fire management as a "support tool" for Land Management. He states, "The fire management team should provide special expertise in fire ecology, fire control, fire use, fire prevention and economics that land managers need to reach their defined goals." In other words, it is an integral part of land management. In this publication we will treat fire management as such.

Fire and Land Management Objectives

Forest and range fires occur naturally in many regions of the United States. Man sets up certain functions for almost every acre of ground so that the land may be useful and productive. Fire, then, may be wanted or unwanted, depending on the specific land management objectives for that area. Fire is managed in each area according to policies set by the public or private owner.

Use of Fire

Fire may be wanted by the land manager for several important reasons. Wildfire prevention and control is one major reason--prescribed fire is used to reduce accumulated forest fuels that pose serious threats to the forest from wildfires. The resources of the forest are thus protected. In timber management, certain tree species are valuable while others are of less value. These less valuable trees compete with commercial species for growing room and can reduce production. For example, prescribed fire may be used to control competing thin barked hardwood species with little or no injury to thick barked conifers. Species control is often used in the pine forests of the South to reduce the number of competing hardwood trees so as to release pines for faster growth.

When timber is harvested, much planning goes into the methods of establishing a new stand of trees. Many commercially important tree species require full sunlight and mineral soil to become established. Where a mature stand is clearcut, all the trees are harvested to open up the site to full sunlight. This is often followed by prescribed fire to expose the mineral soil by burning off logging debris and some of the litter from the forest floor. This not only exposes the soil but reduces flammable debris, makes tree planting easier, and assures its success.

"Wanted fire" vs "unwanted fire." Francis Marion National Forest, South Carolina. F-465063

At one time, the timber stands on both sides of this firebreak were alike in stocking. After the firebreak was installed, the forest on the right was periodically prescribe burned to reduce the accumulated fuel; the stand on the left was not. Aided by the heavy fuel buildup, an unwanted fire proved almost disasterous to the stand on the left. The residual trees were salvage cut to condition shown.

Wildlife habitat can be improved by the planned use of fire. Many wildlife food producing plants are prolific sprouters after fire. Natural cover for wildlife can also be manipulated and improved to manage certain species.

Grasslands and cattle ranges can be rejuvenated by prescribed burning. Dead vegetation is removed and the resulting mineral nutrients are recycled into the soil, improving new grass growth. The resulting range will then be better suited to support grazing wildlife or cattle.

Prescribed fires, randomly ignited by lightning, are also used to perpetuate natural conditions in wilderness areas. In areas where fire has been a force in developing the natural existing forest complex, its exclusion can seriously alter the ecosystems. Fire is then wanted and is used as a management tool to preserve and restore the natural systems, such as are found in the wilderness.

Why Control Wildfire?

Land management objectives may dictate that fire is unwanted in certain areas. For example, annually, there are about 125,000 forest and range wildfires in the United States in which 25 people are killed and 1,350 are injured. Homes and other developments are sometimes damaged or destroyed by wildfires. Protection of life and property is just cause for suppressing wildfires.

In 1974, wildfires on Forest Service protected lands burned over 138,000 acres destroying resources valued at over $109 million. Nationwide, about 4.8 million acres are burned by wildfires each year.

The loss of timber alone can have an important impact on the national economy. Intense wildfires can burn off the protective layers of forest litter and humus and expose the soil to wind and water erosion. Productive soil and ashes can be washed into streams by the rain; the resultant sedimentation can kill much of the stream's aquatic life. The increased runoff from unprotected watersheds in southern California, for example, may cause tremendous floods, mudflows, and property damage. Muddy water can damage water supply systems and devalue water-based recreation activities. Forests that have been burned by unwanted wildfires may have reduced aesthetic appeal to the tourist. Recreation industries may suffer when tourists stay away from burned areas. Fortunately, wildlife is usually not harmed by forest fires, since most animals are mobile enough to escape. Fires during nesting season, however, can destroy bird life.

The habitat changes that occur after a fire can be beneficial to many animals. Squirrels that inhabit mature forests will move away if the trees are killed by fire. Rabbits and deer, though, will move in as the area revegetates with succulent grass shrubs. Burned areas are also a major source of elk browse and critical to some moose range.

Heavy concentrations of smoke may be an unwanted effect of fire, which causes visual pollution and reduces visibility along some highways and fouls the air. A fire that results in such problems is unwanted. In summary, land management objectives define uses and priorities for most of the land in the United States. Fire may be wanted and very useful in many instances but in others it can cause damage and is definitely not wanted. This natural force, which is fire, must be managed to produce the greatest good for the area's overall management objectives.

Policies

The fire management policies of resource agencies vary due to the different functions that each must perform. Over the years, the Forest Service's standard policy has been to suppress all fires as fast as possible. Exceptions are allowed when they are preplanned and approved by the Chief of the Forest Service. Prescribed fire is one of these exceptions. A new concept within this policy, called DESCON (Designated Control Burn System), allows naturally caused as well as man caused fires to burn if they can accomplish preplanned and preapproved management objectives. Surveillance is kept on all prescribed burns--natural and man-set.

In the U.S. Department of the Interior, the National Park Service actively practices fire suppression but it realizes that lightning fires are a natural phenomena and so some of these fires may be allowed to run their course. The fire must be containable within certain area units and should accomplish specific land management objectives. In general, man-set wildfires are suppressed on National Park lands.

Three other Department of the Interior agencies--the Bureau of Land Management, the Bureau of Indian Affairs, and the U.S. Fish and Wildlife Service--are geared toward resource production and use. They have policies that require total suppression of wildfires but allow some preplanned prescribed burning on the lands they administer. All of the Federal agencies control fires vigorously whenever the fires threaten life, physical developments, or cultural areas.

State and local governments also have laws and/or policies that require fire suppression on lands they administer. More public agencies, however, allow prescribed burning for certain management objectives. For example, Oregon approves of brush and slash burning to improve sites for Douglas-fir seedling planting. The city and county of Los Angeles have used prescribed fire to reduce fuel build-ups in the chapparal brush in their areas. Los Angeles also cooperates with the U.S. Forest Service and the California Division of Forestry in fighting wildfires of mutual concern. New York State has allowed prescribed burning in game management areas. Virginia recommends prescribed fire in regenerating loblolly pine. Private forest industries fight all wildfires that threaten their timber resources--damaging fires cannot be tolerated by land owning companies growing trees for profit. Preplanned prescribed fire, however, is used by the forest industries in many parts of the country as a silviculture tool to enhance timber production and forest protection. It is now in great use, especially in the South.

FOREST AND RANGE FIRE CONTROL

The objective of fire control is to provide protection to human life, natural and man-made resources from intolerable losses due to fire. Intensity of protection varies according to the need to ensure human safety, property and resource value, and management objectives. Control of wildfires is a high priority policy for all forest-related agencies. There are three basic procedures in fire control: prevention, presuppression, and suppression.

Prevention

The elimination of preventable, usually man-caused fires, is a goal of fire prevention. Reducing carelessness and eliminating incendiarism are never-ending activities of all Forest Service personnel, other Federal agency fire control organizations, State fire control agencies, forest industries, and private citizens. To prevent fires, the risk, or chance of a fire starting, must be lessened along with the fire hazard (the ease of ignition and the difficulty of putting a fire out.)

Fire prevention is accomplished by a number of means:

(1) Personal contacts inform people of the problems associated with unwanted wildfires; the protection of human life, property, timber, watersheds, and wildlife are emphasized. The ranger's discussions with recreation visitors touch many topics, including how to build a safe campfire, how to put it out, and how to report wildfires. Other subjects such as things to see and do on the forest

Children are firefighters, too. Mt. Baker National Forest, Oregon. F-514868

Smokey Bear and his fire preventing friends. In lieu of the live Smokey, the Smokey Bear costume has been successful in captivating millions of children and adults at fairs, parades, meetings and in the Nation's school rooms. An early understanding of the values of the forest resources and what wildfires can do to them can go a long way in advancing conservation, frequently into adulthood.

which may make the vacationer's trip more enjoyable and meaningful are also discussed.

(2) Education is another important method of achieving fire prevention. The public needs to be informed of the reasons for good fire management and its stake in it. Numerous schools and public organizations are frequently visited. Films, lectures, TV, radio, posters, brochures and the Smokey Bear Campaign are especially effective in showing why fire management is needed.

(3) Advertising is a highly productive way of making large masses of people aware of the importance of fire prevention. The Smokey Bear forest fire prevention campaign first appeared in 1945 as a cooperative effort of the U.S. Forest Service, the State foresters, and The Advertising Council. In 1950, the living symbol Smokey Bear was found in a burned section of the Lincoln National Forest, New Mexico, and was brought to the National Zoo in Washington, D.C. where he has resided since. The first bear retired in 1975 but a new bear has taken over. The Smokey Bear Prevention program is credited with cutting the number of forest fires in half. This program is not just a mass media advertising campaign. It is supplemented by education programs, personal contacts, personal appearances of costumed Smokeys, and hundreds of thousands of children who write Smokey each year. Smokey Bear has his own Congressional Act which protects his image from unauthorized commercial exploitation. In 1975, royalties from commercial producers of Smokey Bear items, ranging from dolls to charcoal briquettes, came to almost $160,000.

(4) Federal and State forest regulations and fire prevention laws serve to reduce man-caused wildfires. Fire prevention clauses are included in National Forest timber sale contracts and other Forest Service contracts and land use permits. These clauses deal with fire suppression plans, fire crew availability, tools needed, adequate disposal of logging debris, and proper use of chain saws and other equipment. Frequent inspections of industrial operations on Federal lands make certain that precautions are taken against accidental fires. Although there are no unnecessary restrictions on the public at National Forests, some regulation may be needed. Camping, open fires, and smoking can be restricted in high risk areas. During high fire danger periods, the forests may be closed to loggers and recreationists. These closings do not usually last long and are designed to protect life and the valuable forest and range resources.

(5) Hazard reduction through fuel management is yet another method of fire prevention. The amount of flammable material is reduced in critical areas so that the incidence of fires is decreased. Trees and brush may be removed from hazardous railroad and powerline rights-of-way. Often, vegetative conversion to other species is employed over large areas. Plant species that readily burn are

removed and replaced by another, less hazardous ground cover. Annual grasses are replaced by perennial grasses that remain green longer, less flammable into the fire season. Brushlands can be converted to less fire prone vegetation. Inpenetrable brush, called chapparal, burns readily and can be very dangerous. For example, on the Tonto National Forest in Arizona, prescribed burning is used to remove the brush so that more desirable grass species can be planted to replace it. Cattle and mule deer now graze on that Forest and there has also been an increase in the area's water production while the main objective of reducing wildfires has been achieved. Prescribed burning can also be used to reduce logging slash fuels after harvest cuts. It may also be employed at other times, during a forest stand's life when ground fuels build up to dangerous levels. Other methods of reducing fuel hazards include felling large dead trees called snags, lopping unusable tree tops so that they lay close to the ground and rot more quickly, and machine-chipping logging debris. Another aspect of fire prevention is concerned with equipment modifications such as chain saw and railroad engine spark arresters and the dangers posed by catalytic converters in autos, and other equipment sources of preventable fires. In summary, fire prevention attempts to stop as many fires as possible before a fire even begins.

Presuppression

Presuppression is the planning and preparatory work done before a fire occurs to ensure effective fire suppression action. Maintaining an effective, properly staffed, trained and equipped fire control organization that can detect and attack unwanted wildfires safely, quickly, and efficiently is the objective of a good presuppression plan. Presuppression plans are handled from several aspects.

Maps are one of the basic sources of information in fire control planning and administration. They are of critical importance in actual suppression action in the field. Topographic maps are used to show the lay of the land and the location of many man-made structures such as buildings and roads. Maps delineating forest access routes and travel times are needed for the transport of men and equipment to fires. Fuel maps indicating various fuels in terms of rate of fire spread and resistance to control are important in planning fire-fighting tactics. Fire occurrence maps and maps of burned over areas are also vital to good fire management planning.

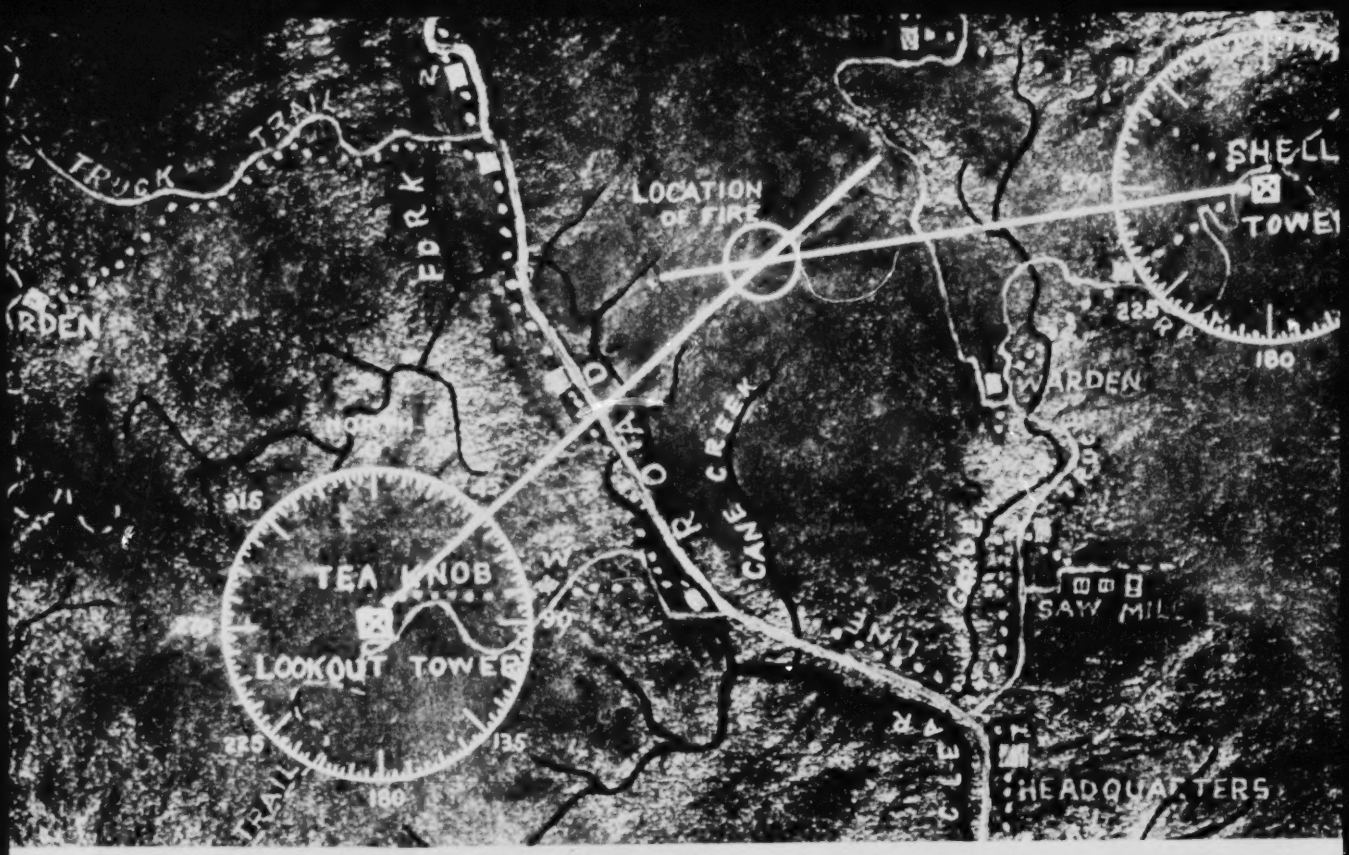
Fuelbreaks play a major role in pre-suppression. They are long, wide strips of land that have had the fuel modified on them so that large fire-prone areas are divided into smaller parcels for easier wildfire control. Hazardous fuels are replaced with less burnable fuels and the breaks are strategically placed for fighting anticipated fires. Fuelbreaks provide important safe areas for firefighters to begin

fire control activities. Access routes are made along many fuelbreaks to facilitate fast fire control. These multi-use routes are often used by the public for many recreational activities. Fuelbreaks provide the opportunity to use prescribed fire in fuel reduction projects by acting as a control line from which to start prescribed burns. Forage for wildlife is increased because of the many grasses selected for use on fuel breaks. Many other species of wildlife are attracted to the interface between large expanses of brushland and the less dense grassy fuelbreaks.

Firebreaks are similar to fuelbreaks, but all of the fuel is removed from a firebreak down to the soil. When prepared in advance of fire occurrence, they too become a presuppression tool. The objective is to create a positive barrier to stop or check fires, provide access, and have an area from which to start control tactics. Firebreaks are used only where soil erosion will not be a problem or when grass seeding will take place immediately after use.

Firefighter training is conducted throughout the United States wherever firefighting crews are located. Classroom and field training are provided so that each firefighter will be able to accomplish his assigned task efficiently and safely with a minimum of supervision. Films, lectures, and texts deal with all phases of fire control. Fire simulators, first invented in 1963, present realistic audiovisual representations of fire control in simulated actual forest conditions. They are low cost, portable training aids for fire control personnel throughout the country. Increased proficiency in sizing up fires, assigning men, planning attack strategies, and forecasting fire behavior have been attributed to the use of fire simulators. Field instruction includes radio operation, use of tools, safety, physical conditioning, and actual firefighting. Firefighters must also meet physical fitness standards which assure they will have the energy to endure the arduous tasks demanded in firefighting. All agencies involved in fire management have joined together to design training courses which will maximize efficiency and reduce duplication of effort.

Soon after forest firefighting organizations were first instituted, it was recognized that a system for measuring and evaluating the variable factors of fire danger was needed if fire control was to be effective. The first devised scale was used in 1930 and by 1954 there were eight major measuring systems in use in the United States. The need was then seen to have one uniform system throughout the country. To satisfy this need the National Fire Danger Rating System was introduced in 1970. It is designed to provide foresters and other land managers with information on current fire danger so that the best decisions can be made regarding the commitment of men and facilities. The system integrates many complicated factors such as fuel models, rate of energy release, rage of fire spread, and weather



Know your territory--Fire trainer's map. Washington, D.C. F-322531

Training map showing locations of lookout towers, fire wardens' homes, sawmills, communication lines, geographic features, roads, trails, mines and other details are fundamental to any presuppression plan. Presuppression is the "prepare and be prepared" activity of fire management performed before the fires come.

Presuppression. Shawnee National Forest, Illinois. F-438079

Fire plow, pulled by a tractor, clears a firebreak down to mineral soil. This plow is particularly effective in broom sedge, grass, and similar vegetation types. The firebreak serves as a barrier to the spread of potential surface fires.

measurements. By using this sophisticated system, fire managers can provide quick and reliable indicators of fire danger for small areas. Research is continuing on the development of other indexes which will be even more useful to fire control agencies in protecting the forest resource.

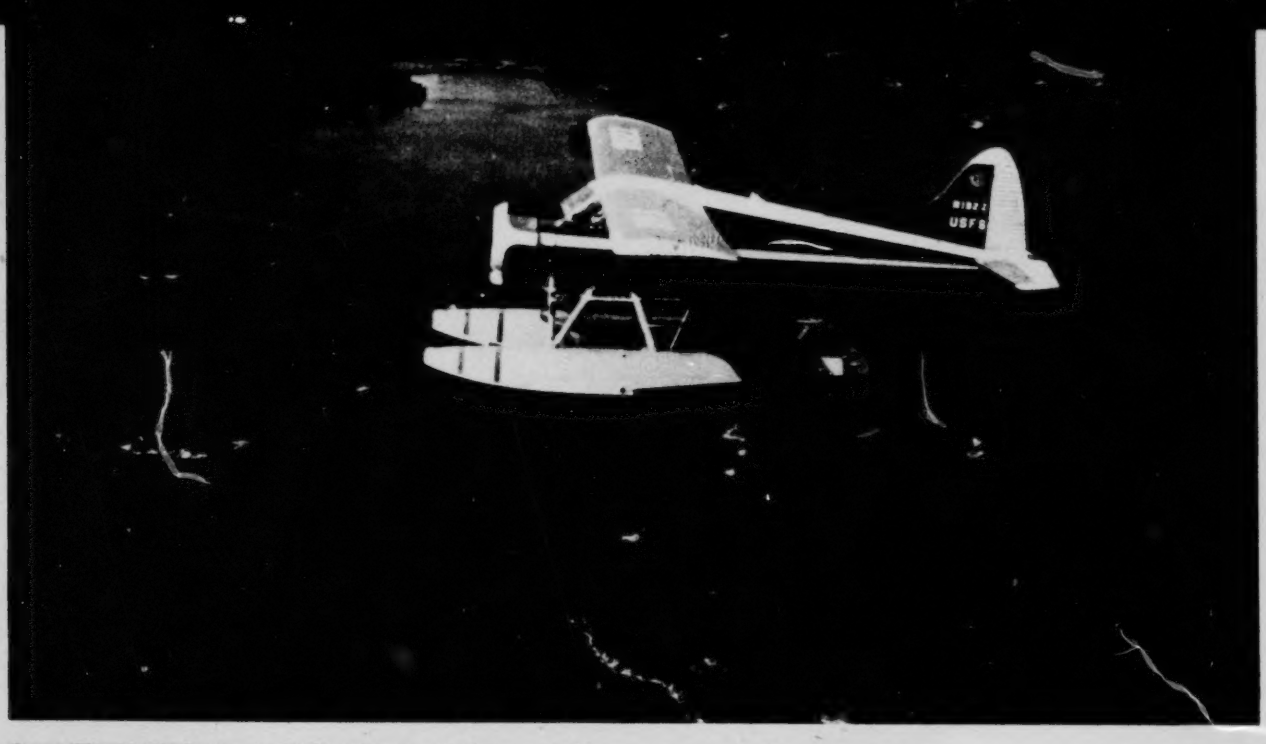
Detection

Detection of fires as soon as they occur is vital if wildfires are to be controlled while they are still small. This ensures rapid initial attack; in many cases a minimum amount of area burned makes firefighting easier and reduces the cost of suppression. Detection systems are established by analyzing risk, types of fuel, resource values, visibility, and topographic characteristics. Areas with critical values--human, developed, or natural--are guarded more closely. Fire towers, aircraft, forest workers, and the general public all play a part in fire detection systems.

At the turn of the century, there was only limited wildfire protection in the United States--performed mostly by lumber company patrols. Preceeded by observation platforms in tree tops, the first wooden fire tower was constructed in 1900 and brought in a new era of forest protection. Towers were designed to provide the greatest visibility and maximum amount of coverage for an area and so were usually built on the highest mountains. Good eyes, knowledge of the region, and the patience to conduct slow, systematic scans of the entire area are requirements for the lookout personnel. The location of the fire is made with the use of a firefinder--an instrument similar to a large compass with the directional degrees from north printed along the perimeter. Fire or smoke is spotted through a set of sights and the compass direction to the fire from the lookout is then determined. Crossing direction readings from two lookouts are needed to pinpoint the fire's location.

Lookout towers can provide constant coverage for their detection area but are expensive to man, do not always provide complete information, and have many blind areas where visibility is restricted. Hence, over recent years, the use of fire towers has decreased while aircraft detection has grown.

Aircraft, being very mobile and covering large areas quickly, usually provide complete reports, and flights can be made as needed during the fire season. Airplane patrols were first employed after World War I and now there are several hundred lookout planes being used in the United States by the Forest Service. Flights are planned to give the best possible view of the ground--routes are made parallel to main waterways so that smaller drainages can be viewed and the proper altitude is picked for each area. Speeds average 120 to 185 mph.



Fire lookouts in the sky. Superior National Forest, Minnesota. F-494904

Planes and helicopters are taking over more and more of the detection duties of lookout towermen. With this trend, there has been a gradual phase-out of the lookout tower in many places.

Dispatcher. Shasta National Forest, California. F-474426

There's where the fire is--where those two lines cross! Lookouts report the compass direction of detected fires from their towers to a dispatcher. With intersecting bearings from two towers, the fire is precisely located and suppression crews are promptly sent to it.

Airplanes can now be equipped with advanced infrared scanners. Infrared imagery detects heat so that the outline of fires can be "seen" at night or when obscured by smoke or fog. At present, three aircraft equipped with infrared sensors are stationed in Boise, Idaho, at the Boise Interagency Fire Center, for use throughout the country.

Fire Suppression

Fire suppression is the work of confining and extinguishing a fire. The Forest Service fire control policy states that suppression of wildfires will be fast, energetic, thorough, and will be conducted with a high degree of safety for the firefighters. All possible efforts should be made to control the fire during the first day of attack. If this is not possible, the fire crew should strive to control it by 10 am the next morning. The speed, strength, and type of suppression attack are governed by the fire's location, its size, and its reaction to the surrounding environment.

Wildfire respects no property boundaries. Cooperation between all wildland management agencies is a necessity in preventing and fighting wildfires. Fires often occur in remote regions, far from fire suppression headquarters. A different agency's fire crews may be closer to the fire and can therefore reach the fire quickly. This is the "closest man" concept--the crew that is closest to the fire is sent to that fire regardless of agency and ownership of the land.

It costs money to fight fire and the sharing of people and equipment between resource agencies is a necessity. It was also recognized that each agency could not afford to duplicate all the people and equipment necessary to fight infrequent but large and disasterous wildfires. The Boise (Idaho) Interagency Fire Center (BIFC) was consequently established in 1970 by the Forest Service, the Bureau of Land Management, the Bureau of Indian Affairs, the National Park Service, the National Weather Service, and the States to coordinate fire control activities. The Center is jointly staffed, equipped, and financed by these agencies. The concept of total mobility was shown to be very useful in fighting large conflagrations. BIFC provides logistic support to the agencies by arranging for the air transport of crews and by being a base of operations for the large communications systems needed on big fires. For example, in 1973, 11,000 firefighters were quickly mobilized to fight a series of fires in the West. Two to three thousand firefighters are common on large fires.

The elite firefighting crews in the Forest Service are referred to as Interregional Fire Suppression Crews. Based throughout the Nation, there are 19 crews of 20 to 25 people each. These crews are highly mobile and can be flown to any location in the country within 6 to 8 hours after being dispatched. Intensive forest fire training, with

Professionals. Wenatchee National Forest, Washington. F-520885

Rested, firefighters return to the fray. With 187 million acres of National Forest and Grasslands to protect and manage, the Forest Service relies on highly trained, well equipped personnel to keep fires on these Federal lands under control. These men are moving up on a fire that has been burning for sometime. They are prepared to stay until it is out. Note the hand tools they carry. There will be strong reliance on soil as the suppressing agent.

The lone defender. Hoosier National Forest, Indiana. F-393-479

A lone farmer works to stop a spring burning fire that got away from his neighbor's land. The smoke was reported and the farmer was soon joined by professional firefighters of the Indiana State Forest Service.

special emphasis on personal safety, as well as rugged physical conditioning are required for these interregional firefighters. Other organized fire crews are made up of agricultural workers, American Indians, and Mexican-Americans. Most Forest Service field personnel are also trained and experienced firefighters. They often comprise the initial attack force on their districts.

After a fire is spotted, a message is sent to a dispatcher who then sends people and equipment to contain the fire. Based on frequent reports from the fire scene, he must anticipate and plan for future needs of the suppression crews. Depending upon the intensity of the fire danger potential on the lands under protection, dispatchers can be assigned to areas varying in size from small forest ranger districts to regions composed of numerous ranger districts.

Organization

The fire suppression team must be efficiently organized to fight wildfires effectively and safely. There are four fundamental principles of Forest Service firefighting:

1. Establish a good communications system.
2. Organize to give proper control and direction to resources.
3. Have only one Fire Boss at a time.
4. Organize the six basic functions--command, line, plans, service, safety, and finance.

The six functions are each headed by a chief who oversees their proper implementation. The Command or Fire Boss has the authority and responsibility for managing the whole fire control operation. He must be able to size up the fire and its potential and determine the kind and quantity of firefighting resources needed to do the job. The coordination of all activities is his duty.

The Line Boss is in charge of the actual suppression activities. He organizes the field forces and directs fire control action according to firefighting plans and with special concern for human safety. He has the responsibility and authority to assign crews, ground equipment, and fire aircraft as needed.

The Plans Chief is in charge of fire intelligence. He currently collects and interprets fire data and prepares alternative plans of action for final decision. He is responsible for plan dissemination, public information and fire reports.

Nothing fancy. Nezperce National Forest, Idaho. F-494555

Any useable shelter at the fire site will do. Here a fire boss and his staff have converted a former lookout cabin into a command post. As in a military operation they constantly update the fire situation, plan the control strategy and order its execution.

First, establish good communications. Angeles National Forest, California. F-493210

This fire boss has positioned himself on a knob from which he can view the whole fire. With a shortwave radio, he can be in instant communication with his line bosses and can deploy his firefighting forces and equipment as needed.

Care of personnel and equipment is the responsibility of the Service Chief. He furnishes facilities and personal services for the firefighters, in addition to supervising equipment maintenance. The Finance Chief oversees the numerous financial aspects of firefighting. The Safety Chief provides a predictive analysis of risk to help the organization control loss and injury. He is responsible for inspection and reporting as required by the Occupational Safety and Health Act (OSHA).

An efficient and reliable communications system is one of the keys to successful fire control work. Without it, the coordination of the attack would be very difficult. Lookouts and dispatchers rely on telephones and/or shortwave radios to report fires and to send initial attack forces to them. On the ground, firefighters use portable radios and walkie-talkies to plan strategies, report on fire behavior, and assure the safety of the men. Complicated networks have been set up to insure adequate communications when wildfires do occur.

The fire crews are normally composed of 6-man squads supervised by a squad boss. Three-squad crews are recommended. On a small, quickly detected fire a trained 2-man crew may suffice. Forest Service firefighters must be at least 18 years old and in excellent physical condition.

Equipment

Early firefighters relied only on handtools--axes, shovels, and they even carried water in pails. Much handwork is still needed, especially in remote areas. However, the use of mechanical equipment has grown dramatically. The shovel is still the basic and most frequently used tool by wildland firefighters. Smothering burning fuels with dirt and constructing firelines to mineral soil are a few of the many tasks in which shovels are employed. The Pulaski tool, half axe and half grub hoe, was specifically designed for firefighting by a U.S. forest ranger in the early 1900's. It is used for cutting and digging. Fire rakes are used for fireline construction in light surface fuels such as pine needles, hardwood leaves or where there is little grass cover. Five gallon backpack water pumps are utilized when only small amounts of water are required. For example, small spot fires that have crossed control lines are often easily put out with a few sprays of water and a little raking or digging.

Drip torches facilitate the easy and safe starting of back fires or prescribed fire burns for fire control purposes. They employ a mixture of gasoline and diesel fuel which allows fire to drip from the container. Hand-held, heat detecting infrared scanners that can detect hotspots in the forest litter are now in growing use. They are

employed after a fire has been controlled, when all smoldering embers must be put out. This device is especially useful in locating smoldering smokeless fire. It is a great improvement over the old method of feeling for heat by hand. Disposable paper sleeping bags and fire resistant tents have become standard equipment for firefighters in remote areas.

Tractor-plows are often used in fireline construction where the topography is not very rough. Under favorable conditions, they can construct and hold one or two miles of 6 to 8-foot wide fireline per hour.

Pumper trucks are utilized to scout fires and aid in actual suppression. They can transport 80 to 350 gallons of water and are often vital to complete fire control, especially where a natural source of water is not immediately available.

Airplanes and helicopters are becoming increasingly important in rapid suppression. Transporting firefighters, supplying equipment, dropping fire retardants, and flying reconnaissance missions are the primary uses of fire control aircraft.

Control Tactics

Fire suppression requires that at least one leg of the fire triangle--consisting of oxygen, heat and fuel--be broken. To break the fuel leg, firelines are constructed. These are plowed, bulldozed, or hand dug lines that interrupt fuel continuity by exposing the mineral soil. Application of dirt, water, or chemicals to fuels achieves a multi-faceted objective. Fuels are made less flammable, temperatures are reduced, and the oxygen supply to the fire may be cut off. In each instance, a leg of the fire triangle is broken and the fire is stopped. These are the basic tactics in fire suppression.

In order to fight fires knowledgeably, safely, and effectively, the Forest Service, through years of experience, has developed "Ten Standard Firefighting Orders" that should be thoroughly known by all firefighters:

1. Keep informed of current and future fire weather.
2. Know what the fire is doing.
3. Base all actions on fire behavior.
4. Have known escape routes.
5. Post lookouts for possible dangers.
6. Be alert, calm; think clearly and act decisively.
7. Maintain good communications.
8. Give clear instructions.
9. Maintain control of personnel.
10. Fight fire aggressively but safely.

The strategy in suppressing fire varies with each fire depending on fire weather, fuels, and topography but the procedures can be generalized into several steps. First comes the initial attack, in which the fire is sized up according to burning conditions and fuels. A point is selected to attack the fire where the control action will produce the quickest and most effective results.

Next, a location for the fire line is chosen as close to the fire as possible and yet one that is safe for the crew. Location of firelines depends on the type of fire being fought and involves three basic methods. The (1) direct method of attack involves suppression action right at the fire edge, with a fire line eventually encircling the fire. Wetting, cooling, and smothering agents are often applied to the flames. This type of attack is used predominately on smoldering, creeping, or back fires when it is not too dangerous to stand close to the fire. If the fire is too hot or smokey, then the (2) parallel method of attack is used. Firelines are constructed parallel to the fire edge but far enough away to be safely worked. Under this method, the fires burn to the line and stop. It is employed when tractor plows are available and also if spot fires are starting in front of the fire's edge. The (3) indirect method is used on larger fires such as crown fires--fire burning in the tree tops. The fireline is made far ahead of the fire edge so that the in-between area can be safely burned out by backfiring.

Once the fire line has been located, the work of constructing carefully planned lines proceeds. Mineral soil must be exposed along the entire line, and it must be wide enough to stop the fire. Larger fires require wider lines. The line boss takes advantage of natural fire breaks such as lakes, streams, swamps, and rocky areas wherever possible to make the operation more efficient and effective and swift.

Construction of lines is followed by backfiring, if needed. This action carefully burns out a section of fuels between the established line and the fire front. Deprived of fuel in this zone, the wildfire stops. Backfiring is done only by experienced experts under proper fuel, weather and preparatory conditions.

After the firelines are firmly established completely around, the fire is declared under control. Any unburned islands of vegetation are then burned out. Later on the remaining fire inside the lines is extinguished in the mop-up operation. Logs, stumps, snags and other burning materials are smothered with dirt and/or water. This is done so that new fires can not flare up and cross the firelines which contain them. Unseen smoldering fires called hotspots must also be located lest they flare up and rekindle the fire outside the line again. These have to be felt for by hand but a new infrared scanner now makes the job safer and more efficient in some cases.

Initial attack. Angeles National Forest, California. F-478569

The dispatcher has sized up this small fire--its fuels and burning conditions--and promptly dispatched this modest sized crew to hit it quickly and decisively. After cutting the fire off at its head, this experienced crew soon corralled it with a line down to mineral soil. As can be seen, this was a job for men with shovels and Pulaski tools.

Man against a wall of smoke. Angeles National Forest, California. F-520890

Too smokey to see into. Aircraft equipped with infrared heat sensing devices can plot the behavior of the fire in situations such as these.

Mopping up. Sawtooth National Forest, Idaho. F-04870

After the flaming fire has subsided comes the dirty, hard mop-up work in smoke and ashes with shovel, axe and water, if available. Hot spots must be extinguished so that there is no chance of new fires flaming up and crossing the lines that contain them. The fire is left only after it is finally declared "out" by the fire boss.

Splatter marks on the helmet of this firefighter indicate that earlier he had some help from an aerial bomber, which dropped a chemical retardent on the fire.

Patrolling the firelines after the fire is controlled involves circling the fire on foot and extinguishing spot fires that have crossed or threaten to cross the control lines.

The fire is abandoned only after it is finally declared "out" by the fire boss. Fire reports that include data such as fire cause, origin, topography, and estimates of damage are then filled out and made available for use in future planning and research.

Specialized firefighting crews have been formed and trained to fight wildfires in rugged and remote terrain. Helitack and rappelling techniques are among the newest methods of personnel delivery. Helitack is simply the use of helicopters in transporting and landing firefighters short distances from fires in rugged terrain. Two or four-man helitack crews begin the initial attack on many fires. Rappelling crews descend to the ground on ropes suspended from hovering helicopters in especially rugged terrain. Without this quick strike force, suppression action would be more difficult and costly and the fire damage much more severe. At present, the Forest Service uses about 150 helicopters for transport, fire retardant drops, reconnaissance, rappelling and helitack purposes.

Smokejumping is often romanticized as the most glorious aspect in firefighting. Actually, it is hard and dangerous work involving rigorous physical training as well as regular fire training. Smokejumpers parachute from airplanes to fires in remote, inaccessible areas which are distant from the fire protection base. This technique was first used in 1940 when a special, easy maneuvering parachute was invented by the Forest Service. Equipment and clothing were designed to provide maximum safety for the men. At the advent of World War II, many Forest Service smokejumping ideas were adopted by the Armed Forces for paratroop training. Presently about 450 smokejumpers are employed by all Federal agencies, with training schools and bases in eight locations throughout the West and Alaska.

Support from Aircraft

Aerial support of ground firefighting forces involves reconnaissance, transport of firefighters and supplies, and water and chemical drops. The Forest Service and the Army air force experimented with the use of planes for detection purposes as early as 1919 in California. The Lake States and the West States used airplanes increasingly through the 1930's for detection purposes as well as supply drops. The Forest Service now contracts from private individuals for several hundred fire detection planes each year. Infrared fire detection equipment is being used at night for fire mapping to improve the speed and efficiency of control activities.

Precision work. BLM Alaska Lands. BLM photo.

Initial attack on a small fire can also be performed with "water bombing." Here, a helicopter hovers while it releases 150 gallons of water. Dousing the head of a small fire tends to delay it and keep it small until firefighters arrive to extinguish it. In the Great Lakes States and Canada, fixed wing hydroplanes, without stopping, scoop water into special tanks while skimming the surface of lakes. Completing the air drop they return and repeat the process over and over again as this helicopter is doing.

Buying time. Angeles National Forest, California. F-506137

A chemical slurry fire retardant is dropped by a PBY air tanker to cool down a hotspot that has erupted. Air drops of chemicals are frequently used to hold a small fire until suppression crews arrive to control it. Later, the chemicals in the slurry double as fertilizer to promote the growth of healing vegetation.

Elite firefighting professionals.
Wenatchee National Forest,
Washington. F-520092

Helitack crew disembarks at the site of the fire and scurries to attack the fire immediately. The key to wildfire control is to corral it while it is still small. This calls for early detection, rapid transportation and prompt initial attack. During periods of high fire danger the helicopter can deliver men to highly inaccessible back country, rapidly. In this case, the pilot found a suitable place to land his chopper.

What is in the future?
Willamette National Forest,
Oregon. F-521020

Rapelling--a new way to go to a fire. In areas where a helitack firefighting crew cannot be delivered by landing the helicopter, rapelling can be employed using lines as long as 250 feet. The Forest Service's first rapelling crews went into action in Oregon and Washington in the summer of 1976.

Air tankers have been employed since 1954 to drop water and chemicals on or near fires. They are utilized for several functions: attacking and holding small fires until fire crews arrive, building temporary retardant lines in advance of a fire, and cooling down hotspots. These drops are most effective in open timber, grass, or scattered brush areas--they are not very effective on high intensity crown fires.

There are two types of fire control chemicals. Retardants reduce or inhibit fuel flammability and thus decrease the fire's rate of spread. Suppressants extinguish the flaming and glowing combustion of fuels. These compounds are formulated to be non-toxic to plants and animals and non-damaging equipment.

The two most widely used chemical-water mixtures are both fire retardants. They contain ammonium compounds, that act as flame inhibitors, and a water thickening agent. The thickening agent makes water more viscous, or more resistant to flow. Viscous water has properties which aid in fire inhibition: it sticks and clings to many fuels and it spreads in a thick layer over all fuels. This increased amount of adherant water absorbs more heat than normal films of water, thus reducing the amount of preheating of the fuels. This action can significantly decrease the fire's rate of spread and facilitates fire control.

The Forest Service contracts for about 60 air tankers--most converted World War II aircraft--which, in 1970, dropped over 17 million gallons of fire retardants. These tankers can hold 800 to 3,000 gallons of chemicals. For maximum effect, they must fly 75 to 150 feet above the forest canopy. As a result, the flights are quite dangerous, especially in mountainous terrain, and so must be flown by highly experienced pilots.

Amphibious aircraft are used in lake country to collect water without stopping and to later release this water on fires. The water is scooped into tanks while the plane skims along a lake. This method can greatly increase the rate of water drop delivery on many wildfires. Helicopters are used for precision dropping of lesser amounts of water on small fires and for delivery of water to holding tanks.

Rehabilitation

The first step in restoring an area damaged by wildfire is to determine the size and inventory the damaged resources. Tangible damage is measured in dollars and includes identifiable timber or range losses. Less tangible losses such as aesthetics or watershed values are more difficult to place a monetary worth on.

quickly. Giving nature a helping hand.
Nezperce National Forest, Idaho.
P-922713

Grass to hold the soil in place until
trees can once again take over
the openings. This forest was aerial
seeded to grass immediately after a
fire. It is evident that this prompt
action was highly successful. As a
result, the streams will flow cleaner.

now against time. Lincoln National
Forest, New Mexico. P-519496

Sometimes, after a fire, it is necessary
to go in and plant the rehabilitation
area to trees by hand, as
these men are doing. With good luck
from the weather, this action can
assure the establishment of selected
species of trees which are properly
spaced for fast growth before com-
peting volunteer growth can take over
the site.

If the decision is to rehabilitate the area, discarded materials left over from the control activities are removed promptly. Firelines and roads are seeded with grasses and legumes. Streams and streambanks that may have been damaged or altered by tractor-plows are restored to their natural conditions. Soil erosion on mountain slopes is reduced as quickly as possible by seeding quickly established plants such as rye, fescue, clover, mustard, and bluegrass. Subsequently, these seeded areas often turn into excellent rangelands for cattle and wildlife.

One of the largest rehabilitation projects ever undertaken was performed on the site of the 1933 Tillamook (Oregon) burn. Access roads were built into the area and many of the fire-killed trees were salvaged for timber purposes. Over 255,000 acres have been seeded or planted to native trees to restore the timber, watershed, wildlife, and recreational productivity of this once devastated area.

In summary, it can be said that fire control is a many-sided program used to combat forest and range fires throughout the country. Fire prevention involves stopping potential fires before they ever occur through public education, cooperation with industry, and regulation of forest use during high hazard times.

Presuppression ensures that a fully prepared, properly equipped firefighting force will be ready to attack any wildfire within its jurisdiction. Fire suppression is the task of confining and extinguishing a fire.

The motto of suppression action--"Hit 'em hard and keep 'em small," pays off. With the cooperation of many land management agencies and the use of highly trained personnel and modern equipment, wildfires can be controlled quickly. Damage to resources can be kept to a minimum and the forest and range can be restored as rapidly as feasible. When management objectives dictate that a fire is not wanted, every effort is made to control and extinguish it promptly.

PRESCRIBED FIRE

Prescribed Burning--Its Development

Fire in its proper place, in the right hands, at the right time, can be an asset and an effective tool in land management programs. Prescribed burning is fire used as a management tool. It is the skillful application of fire in a definite area under pre-determined weather and fuel conditions to achieve specific results. These

prescribed fires are initiated and controlled by experienced foresters, wildlife biologists and other resource specialists. Natural prescribed fires (fires in wilderness areas pre-programmed for burning) are often started by lightning. Both types of fire are carefully watched to assure that they achieve the planned management objectives and do not become destructive. If the fire's behavior changes and threatens to produce unwanted results, then it is promptly put out. Only under proper (safe burning) conditions are prescribed fires allowed to burn.

One of the earliest uses of prescribed fire was in the southern New Jersey cranberry bog region. The fuel bordering the bogs were burned in order to protect the cranberries from the prospect of damaging wildfires entering the bogs. In the South, the 1890's saw the introduction of new ideas in the use of fire in longleaf pine silviculture. Eventually, prescribed fire was tested on the southern National Forests and is now a common forest management practice. New Jersey State forests began using prescribed fire as early as 1928 to protect their valuable pitch and shortleaf pine resources.

Carefully controlled fire is now widely employed by land managers for many purposes. For example, in 1970, it is estimated that prescribed fire was used on 2.5 million acres in the United States while wildfires burned only 2.25 million acres. It is finally being recognized that fire does have many beneficial protection and ecological effects and can be used as a tool in forest and range land management.

Uses of Prescribed Fire

Prescribed fire has been found to have numerous applications in resource management. The effects of fire, in these cases, are predetermined, are wanted, and are desirable. Fire can perform multiple functions when properly used with both the principle objective and related beneficial results being achieved.

Prescribed fuel or hazard reduction is the most common use of fire. Without it, the management of many forests would be more difficult and perhaps unprofitable.

With the advent of total fire protection, there was a departure from the natural cycle and, in some areas, fuels accumulated to the point where fires, when they occurred, were very severe. Prescribed fire is intended to reduce fuel supplies on the floors of selected southern and western pine forests by burning the accumulated grass, pine needles, and small shrubs in order to cut down the threat of crown fires. Since fires in these pine forests occurred in natural cycles of fuel buildups--there was enough continuous fuel to sustain the

resulting light surface fires. Prescribed burning in a way simulates this natural condition.

Fuel reduction prescribed burning in southern forests is usually conducted during the winter every 2 to 4 years. This simulates the natural fires that once occurred there. Complete coverage of entire tracts is not needed--the objective is to break up the fuel continuity so that large contiguous wildfires cannot develop. This objective is considered "accomplished" when 80 percent of the area has received fuel reduction treatment. With this objective in mind, the Forest Service annually prescribe burns about 650,000 acres of National Forest lands.

In the timbered sections of the West, many commercially important softwood trees need full sunlight to reproduce. Clearcutting patches of varying sizes and shapes and burning the slash residue produces the desired result. This double benefit practice greatly reduces the wildfire hazard while preparing the land for a new generation of trees.

Hazard reductions can also be accomplished through vegetative type conversions. For example, the sagebrush and chaparral cover types of the Southwest and California are often considered nonproductive and are highly flammable. With the carefully planned use of mechanical brush choppers, prescribed fire and seeding to grass these areas can be converted into productive rangelands while simultaneously lowering the fire hazard.

In the Intermountain Region of the West, cheatgrass--often called the torch of the western rangelands--invades overgrazed ranges. It is a highly flammable and undesirable for efficient livestock production. Early summer prescribed fires reduce its abundance and allow desired grass species to reinvade the area.

Site preparation is the practice of making the forest land suitable for tree planting or natural seeding or sprouting. Pine and Douglas-fir seeds, like most evergreens, must have mineral soil to germinate and grow properly. Prescribed fire serves to remove some of the forest litter and expose the needed mineral soil. The side benefit to burning of logging debris immediately after harvesting is a reduction in the fire hazard threat to the young succeeding trees. For example, studies in the Douglas-fir and white pine region have shown fire rates of spread to be slowed for up to 15 years after initial burning. Reduction of the amount of slash facilitates and reduces the cost of tree planting. Unwanted brush growth that would compete with tree seedlings can be held in check for several years by site preparation burning.

In addition to being used in the South and West, site preparation with prescribed burning is also practiced in the North Central States. Jack and Red pine and black spruce both have serotinous cones--that is, they require heat to open up and shed their seeds. Once dropped the seeds of these species must have mineral or exposed peat soil to sprout and grow. Fire fits Jack and Red pine and black spruce management very well. It can be used to open the cones, and release the seed, expose the soil, and to reduce competition from shrubs and other plants.

Quaking aspen, an excellent raw material for papermaking, reproduces prolifically from root sprouts after the trees are clearcut. Prompt prescribed fire treatment stimulates this root suckering by removing excess litter, logging debris, and competing overstory bushes and trees. Burning is usually accomplished in the fall or early spring to ensure an abundant growth of sprouts during the summer. Nationwide, each year, the Forest Service prescribe-burns about 40,000 acres of National Forest land with the primary objectives of site preparation for regeneration purposes.

Insect and disease control is another growing beneficial use of fire. For example, in the South, young longleaf pines are weakened and killed by the brownspot needle blight disease. This fungus infection kills the needles on which the seedlings are dependent for growth. Fortunately, these longleaf pine seedlings in the "grass stage" (up to 7 years old) are very resistant to light surface fires when they reach diameters of only 1/2 inch or more. Light prescribed fires are employed during the winter at 2 to 3-year intervals to combat this disease. The fire burns the dead and infected needles but the terminal bud and other needles remain unharmed. This practice lessens the incidence of brownspot needle blight disease for several years and also reduces the competition from surrounding grasses. The pines grow faster as a result.

In the West, Dwarf Mistletoe reduces tree vigor and can eventually kill black spruce, Douglas-fir, ponderosa and lodgepole pines, and western hemlock. To destroy this harmful parasitic plant, infected stands must be clearcut and then prescribed burned. The fire kills both the infected saplings and the mistletoe, thus reducing the threat of infection to the new stand. It also lessens the stand's fire hazard and prepares the forest floor for regeneration by exposing mineral soil to the seeds.

Heartrot fungus diseases that destroy the non-living center of living trees are a major cause of timber loss in the United States. Researchers have found that when oak stands, after being harvested, are prescribed burned, the incidence of heartrot in stump sprouts is greatly reduced. This practice could improve the quality and value of many future oak forests in the East, where the problem is of major concern.

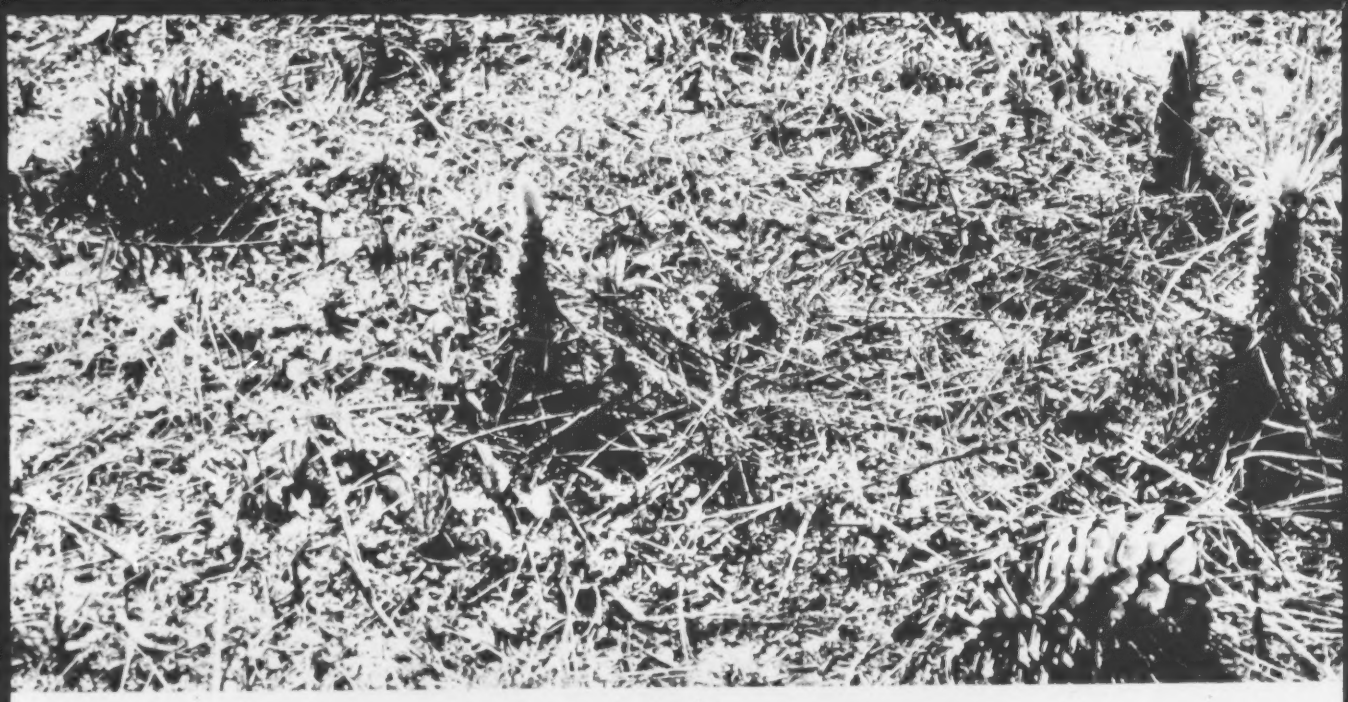
Since some oaks are quite resistant to damage from light surface fires, prescribed burning may be used to remove competing less desirable species and to promote advanced regeneration before the trees are harvested.

It has also been recommended that infestations of harmful pine engraver bark beetles can be reduced by using prescribed fire. These insects hibernate in the forest litter and can be readily killed with the prescribed use of properly programmed fire.

Species control is a forest improvement technique employed to remove competing low value, poor quality trees from stands of the more commercially important tree species. This practice is especially common in southern pine stands where undesirable hardwood competition can be reduced by prescribed burning. Young hardwoods being thin barked, are very susceptible to fire especially if they are three inches or less in diameter at ground level. Both winter or summer burns are used. Although summer fires will kill more hardwoods, if large amounts of fuel are present, less hazardous winter burning is preferable. Prescribed fire enables the pines to maintain control of the site, reduces fuel accumulations, aids in site preparation, and increases hardwood sprouts which are a favorite wildlife browse.

Unlike young hardwoods, pines are more resistant to heat damage because of the insulating properties of their thick bark. Pitch pines in southern New Jersey, for example, are quick to become resistant to fire damage usually when they are about 3 inches in diameter at chest height. Their thick bark, ability to sprout, and early production of cones enables them to survive the periodic wildfires that occurred there. Now, prescribed fire is employed in cycles varying from 1 to 12 years, depending on the amount of hardwood that needs control and the amount of accumulated fuel that exists. This results in pine stands that are producing wood while at the same time providing needed recreational space and wildlife habitat.

Blueberries and other berry-producing shrubs can be revitalized by the use of prescribed fire at the right time and under proper conditions. In Maine, dead and suppressed branches are burned and new vigorous sprouts spring forth. Shading can be reduced, increasing germination of these light-requiring berry plants. Wildlife benefits from the increased food production as does man who uses these berries domestically and commercially. For example, prescribed burning every fourth spring has been recommended for the blueberry wildlands.



Prescribed fire for disease control. Francis Marion National Forest, South Carolina. P-465068

Normally, these young longleaf pine trees would be weakened or killed by brownspot needle blight disease. Fortunately these longleaf pine seedlings are resistant to light surface fires for about 7 years. Light winter burning at 2- or 3-year periods will check the disease. This area was prescribe burned. Note how well the seedling pines have come through the burning.

Making fire pay its way. Apalachicola National Forest, Florida. P-486305

A wildlife biologist examines the abundant acorns of Florida dwarf oak, a favorite wildlife food. This oak thrives and produces acorns the second year after a prescribed burn in pine stands.

Prescribed burning for wildlife habitat improvement involves increasing the yield and quality of grass, herbs, legumes, and browse and the creation of openings for wildlife feeding, nesting, and travel. Annually, the Forest Service prescribe burns about 55,000 acres of forest land for wildlife purposes. Wildlife habitat improvement is the single most important reason for prescribed burning in the North Central States and the Piedmont region of the South. On the Piedmont National Wildlife Refuge in Georgia, prescribed fire is used to maintain open pine stands, thus increasing the numbers of insects and food plants for wild turkey and bobwhite quail populations.

Unburned thickets and stream bottomlands provide needed wildlife cover. Succulent sprouts from hardwood trees and shrubs provide browse for white-tailed deer. Before the nesting season dense stands of rushes and reeds can be opened up by prescribed burning to provide attractive nesting areas for wild ducks and geese. Incidentally, fire also exposes some seeds and roots, allowing the waterfowl to find these food items more easily.

Ruffed grouse inhabit areas where there is a mixture of mature forest and young tree stands. Sapling aspen stands up to 10 years old can provide much of the food required by grouse. Grasses, sedges, berries, and aspen buds are important food items that are found only in young sapling stands. Prescribed burning has been used to maintain these conditions and has produced grouse populations five times greater than those in unburned areas.

The endangered Kirtland's Warbler breeds in the Huron National Forest in Michigan. This songbird's habitat requirements are very specific--5 to 15 foot tall Jack Pines interspersed with grassy openings. The U.S. Forest Service intensely manages this area of 4,010 acres through tree harvesting and prescribed burning to maintain the delicate environmental conditions that this warbler must have.

Moose inhabit water-abundant areas that have both mature conifer forest stands and young stands. The aspen, birch, and willow that invade wildlands after fire are favorite winter browse species for moose. Without these young, rejuvenated stands, moose populations would decline.

The proper management of America's rangelands is a very broad and complex topic. Prescribed burning has an important role in this field, too. Fire can be used to remove accumulation of dead vegetation that hinder new growth development. Simultaneously the nutrients released by burning are returned to the soil and play a part in improving grass growth in the coming season. More specifically, when the dead vegetation is removed, the soil becomes exposed to the sun and heats up faster in the spring. This results in earlier

Prescribed fire. Santee Experimental Forest, South Carolina. F-489082

The wind is right, the humidity is right, and a firebreak surrounds the area being set on fire. Here a drip torch is being skillfully used to fire a predetermined area of loblolly pine forest to reduce the accumulation of fuel on the forest floor. This prevents an excessive fuel buildup which, in the event of a hot wildfire, could destroy this fine stand of pine trees. Prescribed fire of this type seldom kills pines more than 5 feet tall.

Compatibility: Fire-Aspen-Grouse. Hiawatha National Forest, Michigan. F-360537

Aspen comes in thick after a fire. So does the ruffed grouse which finds an abundance of food to eat in sapling stands up to 10 years old. Prescribed burning has been successfully employed to maintain these favorable wildlife conditions which, in the case of grouse, have produced populations five times those on unburned areas.

and in more rapid spring growth. Prescribed fires used every 2 to 4 years can improve the availability, nutritive value, and palatability of range grasses. Judicious use of fire can be also employed to control unwanted woody invaders such as sagebrush, burroweed, and junipers.

The western ponderosa pine forest type, visited by frequent natural fires, historically developed into an open looking forest with grass as the principle understory ground cover. The bark of ponderosa pine being thick and fire resistant--frequent lightning caused grassfires maintained the open parklike stands. However, with the coming of effective fire protection, the stands began to increase in density, and fuel accumulated stagnating reproduction and choking out grasses and herbs. The introduction of springtime prescribed fires decreased the numbers of small pines and reduced the amount of hazardous ground fuels. The pines were better able to grow more wood in less time because of less intraspecific competition and the grasslands were improved.

About 5,000 acres of rangeland are prescribe burned each year by the Forest Service. Prescribed burning to regenerate native prairie grasses is also practiced in the North Central States. Certain undesirable exotic grasses can be selected against, depending on when the burn is conducted.

The main objective in the use of prescribed fire on recreation areas is the safety of users and the protection of the site and facilities from destruction by wildfire. Basically a fuel reduction action decreases potential damage from wildfire.

An aesthetically pleasing diversity of wildlife and vegetation types can be maintained by properly planned fires. Mountain laurel, blueberry, huckleberry, bracken fern, and many other fire dependent species can be rejuvenated and creatively managed with the use of fire. Thinning of dense shrubby growth results in improved view angle, depth perception, and color contrast. A recreation area can thus be displayed to its best advantage.

Open parklike stands with an abundance of herbs and wildflowers are very pleasing to hikers, motorists, and picnickers. Fuel breaks that have been seeded to grass often attract wide varieties of wildlife and can be integrated into forest trail systems. In the southern flatlands, the open stands that result from prescribed burning on the Francis Marion National Forest in South Carolina permit the sea breezes to blow through and drive away mosquitoes that would otherwise greatly hinder recreationists. In the North, on extensive recreational areas in the New Jersey Pine Barrens, for example, prescribed burning is conducted at 3 to 10-year intervals. But, on the higher value, more intensively used New Jersey sites, shorter cycles may be necessary to provide adequate protection from possible wildfires.

As has been previously noted, fire is a natural occurring process on the forests and ranges of many sections of the United States. Their effects sometime reach the Wilderness and Primitive Areas that have been established under the Forest Service and National Park Service to serve as living examples of primeval America. These wilderness ecosystems are dynamic--ever changing--and fire has been a part of the natural process. The periodic occurrence or exclusion of fire can seriously alter this ecological relationship. Already, unnatural changes are occurring on some long protected areas and some segments of the ecosystems are being lost. For certain ecosystems, fire is now accepted as one of the major and most powerful environmental factors that determine which way forest development proceeds on wilderness and primitive areas. Federal laws state that the natural environment must be perpetuated on these areas; if so, the use of fire, if it was present in the primeval wilderness, can be interpreted as logical and proper.

Natural prescribed fire is presently being employed in 20 National Parks and in parts of the Gila and Selway-Bitterroot Wildernesses, and in the entire 585,000 acre Teton Wilderness. About eight other National Forest Wilderness Areas have natural prescribed fire plans presently under study. These natural ecosystems provide cultural, aesthetic, and psychological values; maintain the diversity of flora and fauna; and are valuable to science in terms of genetic reservoirs and in understanding of natural systems, their development and maintenance.

The life cycles and physiological processes of many tree species depend on fire in various ways. Some species require full sunlight and mineral soil to grow and quickly invade burned-over areas. Others have tenacious serotinous cones and thick insulating bark. In summary, it is readily seen that many trees and forest types are fire dependent--through the ages they have adapted to fire in different ways, with one common bond--they all need fire for their natural existence. The continued use of fire will help maintain these forest types. In wilderness situations, the many stages of natural succession that existed prior to fire protection can be reintroduced through the carefully planned use of prescribed fire.

For example, managed fire is playing an increasing role in the maintenance of natural conditions in National Parks and Monuments. Prescribed fire in the Saguaro National Monument in Arizona has removed large amounts of potentially hazardous fuel and has produced natural parklike ponderosa pine stands by fire-thinning the pine reproduction. In another case, the Giant Sequoias of California, until the recent employment of fire management, were being threatened with destruction from wildfires because of the huge buildup of forest fuels resulting from fire protection. Through thousands of years, light surface fires had always maintained these magnificent

forests but fire exclusion was permitting other highly flammable species to invade the area. Presently, with the use of prescribed fire, progress is being made in reducing the fire hazard and the Sequoias are commencing to reproduce more abundantly on the exposed mineral soil. Increasing areas of Wilderness forest types and natural habitats on National Forests are also being maintained or restored with the use of prescribed fire.

Prescribed Fire Policy

The Forest Service and the Department of the Interior land management agencies permit the use of prescribed fire on lands under their jurisdiction if it is preplanned and carefully controlled. Annually, the Forest Service prescribe burns, for various purposes, about 750,000 acres--and sees a need to expand this practice especially for fuel reduction on the National Forests. Natural prescribed fires are used in Wilderness Areas administered by the Forest Service and National Park Service. These are lightning-caused fires and are permitted to burn on areas pre-determined to be in need of prescribed burning. These preplanned and approved fires are allowed to burn if they can accomplish wilderness management objectives, pose no threat to human life or property, and can be controlled chiefly by natural fire breaks within predetermined limits.

About 20 States and numerous private companies prescribe-burn roughly 2.5 million acres of their wild lands yearly. In Southern States it is an established practice to regularly use fire for disease control, vegetative type conversion, fuel reduction, and the management of wildlife habitat. Seedbed preparation, wildlife management, and blueberry production are major objectives of fire use in the North. Western States and private forest landowners use prescribed burning mostly for hazard reduction, type conversion, site preparation, and disease control.

Steps in Prescribed Burning

Detailed preplanning is the rule before carrying out prescribed burning activities. Strict control is mandatory in the use of prescribed fire. Through years of experience and testing, five planning steps have been developed to ensure successful prescribed burns. Short circuiting any one of them may cause complications and problems in meeting the planned land management objectives.

The steps are:

1. Diagnosis--the analysis of management problems and what role prescribed fire can and/or should play in meeting objectives.

2. Prescription--actual planning of the burn--objectives, description, weather and season to burn, firing method, control procedures, location of smoke-sensitive areas, and publicity.

3. Preparation--the key to successful burning--become familiar with the area, locate special areas and potentially dangerous situations, plow fire lines, using natural fire breaks when possible.

4. Treatment--the actual execution of the prescribed fire--burn carefully, constantly check weather conditions, notify neighboring residents prior to burning, post signs on roads, use test fires, maintain good radio communications.

5. Appraisal--Did the fire meet land management objectives? Any damage to site? Was the smoke satisfactorily dispersed?

Proper Conditions for Prescribed Burning

The right combination of weather, fuel, and topographic conditions must exist if prescribed fire is to be safely used. The amount of available fuel can be greatly modified by weather conditions, since relative humidity governs the fuel moisture content and thus the amount of burnable fuel. Relative humidity of 30 to 50 percent is preferred on most burns. Lower humidity results in more intense and dangerous fires, while the same fire area may not even burn at high humidity levels. Some rain is usually preferred several days before the scheduled burn to ensure that the lower layers of forest litter are moist enough to protect the mineral soil.

Areas with steep terrain are difficult to prescribe-burn because of potentially violent fire behavior on the slopes. But with correct placement and construction of firelines, favorable weather, and careful burning practices, fire can be employed on fairly steep slopes. Experiments in the South have shown that prescribed fire, if properly used, causes little or no soil erosion, even on moderate slopes due to the ground litter cover that is left.

Weather is the most variable factor in fire behavior. It is imperative that it be frequently monitored and that precise information be secured concerning present and predicted future weather conditions. Reports from the National Weather Service provide information regarding

general winds and weather patterns. This agency also prepares special fire weather forecasts during fire seasons. These are vital in deciding when to burn. Field data are also important. Portable weather kits have instruments which have been developed to measure humidity, windspeed, and temperature. Cloud observations also provide useful information. If the right weather and related conditions exist, the fire may be ignited--otherwise the treatment must be postponed. Other factors are also considered in planning the time of burning. Prescribed fires, for example, are not scheduled during the major bird nesting period in the spring.

Control and Tactics

Prescribed burning crews vary in size depending upon the fuel type, expected fire behavior and acreage to be burned. Four-man crews in New Jersey can prescribe burn about 500 acres in one day while on more rugged topography, crews of 20 people may be needed to safely treat a much smaller area. Cost varies also but, on the whole, no alternate treatment has yet been developed that can compete with fire as a forest and range management tool from a standpoint of practicality, cost, and the small amount of adverse environmental impact that results. Whereas costs from mechanical slash and fuel treatments may run from $25 to $50 per acre; on large areas, prescribed fire can produce the same result for as little as $1 per acre; on smaller areas, prescribed burning may run from $10 to $15 per acre.

Firelines, sometimes constructed by hand but more often by tractor-plow units, must expose the mineral soil around the entire tract to be burned before firing begins if maximum control is to be achieved. Crew members are assigned to specific duties such as patrolling the backfire line or lighting the fire. The fire must be started carefully and quickly by using drip torches or flame throwers. Backpack water pumps and fire rakes are used by the line patrolmen who follow behind and put out any small fires that may jump the fireline.

Over the years, the art and practice of prescribed fire has developed into a fairly sophisticated procedure in the managed use of fire. Broadcast burning, logging slashpile burning, and windrow burning are the three general types of fire employed. Broadcast burning itself can be further classified into six types of fire--backfire, strip-head fire, flank fire, spot fires, ring fire, and a chevron burn technique. (See A Guide for Prescribed Fire in Southern Forests by H. Mobley, et al.)

Effects on Soil, Water, and Air

Criticisms have often been voiced that prescribed burning is not good for the physical environment--that soil nutrients are lost, water is polluted, and the atmosphere is fouled. But when the smoke clears, there appears to be little longterm environmental degradation from properly used prescribed fire. It has often been implied that nitrogen is lost to the atmosphere through volatilization. But studies have shown that nitrogen as well as other nutrients such as calcium, phosphate, potash, zinc, and copper compounds have been increased in the soil as a result of the prescribed fire release of nutrients in accumulated fuels. The added amount of nutrients in the soil serve to stimulate the growth of herbs, grasses, and tree seedlings. Water resources are little harmed by properly planned fires. Generous strips along streams are left unburned to help contain the nutrients in the burned zone where they can be quickly recycled into the soil and into growing plants to reduce leaching.

With well executed prescribed fire, there is usually more complete combustion but less total fuel burned, as compared to wildfire. This combination produces less particulate matter and hence less total smoke than that generated by uncontrolled wildfire. The resulting gases are mostly harmless water vapor and carbon dioxide. Some carbon monoxide is also produced. Very hot wildfires can produce nitrogen oxides but this is usually not the case in prescribed fires. Hydrocarbons are given off during the combustion process but only in minute amounts. The accompanying light winds disperse these emissions to acceptable levels within short distances of the prescribed burn area.

Smoke causes some problems, for the most part, by temporarily reducing visibility. Wood smoke is predominately water vapor and some small droplets of organic matter condensed on tiny particles of carbon or ash. Although unsightly, it is usually not harmful because of rapid dispersion in the wind. To reduce the visible impacts of smoke, it, too, must be managed for the benefit of the public. The untimely use of fire can cause reduced visibility and an ominous sight over large areas. Adequate planning will help cut smoke's unwanted effects. Generally, burning should be conducted only when light winds and moderate atmospheric instability will quickly dispel the smoke. In the process local residents and motorists should be informed of burning schedules in advance of and during the prescribed burning. Slower burning backfires, because of their more complete combustion, produce less smoke than head or flank fires and should be used as often as possible. Research continues to find better ways of minimizing smoke pollution through improved planning and fire management.

On the whole, with careful planning and implementation of prescribed burning, soil nutrient loss is minimal, and water pollution can be avoided. Smoke nuisance can be minimized and more quickly dispersed under properly selected weather and fuel conditions.

FIRE MANAGEMENT RESEARCH AND THE FUTURE

Research

Projects in fire research were initiated by the Forest Service in 1915. Development of new and improved firefighting equipment was an early and high priority research goal of the Service. Today fire research is being conducted at forest experiment stations throughout the United States with special emphasis at three regional forest fire laboratories at Missoula, Montana; Macon, Georgia; and Riverside, California. About 200 scientists are involved in this high priority effort. As land resource values skyrocket and people keep settling closer to Forest and Rangelands, solutions to fire problems become more pressing each year.

Research is done on all aspects of fire management so that land managers, be they State, Federal or private, will be able to continually improve the decisions they make concerning the use and control of fire in the future. The most pressing research projects for the next 5 to 10 years involve hazard reduction, fire behavior, risk reduction; and improving, planning, and executing protection actions.

Hazard reduction--Research is being conducted on numerous aspects of fuel management. These include the use of firebreaks, fuel modification systems which employ prescribed burning and the testing of mechanical equipment such as wood chippers. Increased utilization of logging residues by burning leftover slash to provide fuel for steam electric plants, in these energy-short days, is an innovative idea that is being currently studied.

Fire behavior--The effects of weather, fuels, and topography on fire behavior are being studied with the use of complicated fire models that simulate natural forest conditions. This should eventually lead to an even more scientific approach to prescribed burning and fire control.

Risk reduction--Fire prevention will continue to be a topic of research as long as unwanted lightning and man-caused fires occur.

Fire safety research. Northern Forest Fire Laboratory, Montana. F-521384

The safety of the firefighter is paramount at all times. Here an experimental face mask to protect the face and eyes from heat when fighting a fire close in is being tested. Over the years many improved techniques in controlling unwanted wildfire and in the use of prescribed fire have been developed by Forest Service scientists headquartered in fire laboratories in Montana, California, and Georgia.

Research and the "better way." Conecuh National Forest, Alabama. F-475617

Result of experimental prescribed burning of longleaf pine by research scientists. First prescribe burned to prepare a seed bed for the seed trees scattered throughout the area--the stand successfully established itself. When the young trees were about the height of the grass in which they were growing they were prescribe burned to control Brownspot Needle disease. Three years later, this beautiful stand of young pines is the result.

Planning and executing protection actions--Those who implement fire management techniques should treat all forest resources as a single integrated system. Since fire is managed to accomplish specific objectives, studies are being conducted on how to make decisions correctly and quickly that will achieve those objectives. For example, faster fire mapping techniques with remote sensing devices such as infrared imagery and laser spectroscopy are now being researched.

When ready for application, this research should provide land managers with the knowledge and equipment with which to more precisely implement complex fire management plans.

Future Management Objectives and Fire

Forecasting the future always involves considerable judgment and some guesswork based on the use of proven factual information concerning present and past trends. Currently, the profession of forestry is in a state of great change. Increased environmental concern by the public, new and changing technologies, and an urbanized society are contributing to a modification of the old values of the forest. Foresters and their resource management practices are learning to adjust and bend more to meet the new challenges and demands of society.

Historically, fire is an integral part of wild land evolution and so must be seriously considered in any plan for the future. It should be done with the understanding that wildfire suppression has been a policy of land managing agencies since their inception around the turn of the century and that control practices are becoming more expensive. The time has come for carefully weighed decisions regarding the future use of these practices and the benefits that are accrued from them. If essential management objectives such as timber production, watershed protection, and the providing of forest recreation opportunities are to be continued, then aggressive fire prevention and firefighting plans must be employed. In this process it must be recognized that certain ecosystems, at varying levels of development, cannot stand the force of fire and that if we wish to beneficially use these areas, fire should and must be kept out. Therefore it becomes a question of identifying these conditions and fully considering the management goals for each individual area and making decisions accordingly.

Research has been an important factor in the accelerating use of prescribed fire as more of the "know-how" for its safe application is perfected. The South needs and already intensively uses prescribed fire. Western, Northern, and Eastern states employ it in

varying degrees. However, there are additional areas of application where prescribed fire could become an important beneficial part of overall management. Native prairie restoration, recreation, greenspace and wildlife habitat management, and the management of additional conifers and hardwoods timber species promise to be areas in which prescribed fire may play a greater role in the future.

Current trends indicate that many of the remaining wilderness preserves will be managed more naturally in the future. If fire was previously a major environmental factor in development of the wilderness, then it seems logical that prescribed fire should be used to maintain these ecosystems as they were before man changed them through fire exclusion.

THE NEED FOR FIRE MANAGEMENT

Fire management can be defined as the integration of fire-related biological, ecological, physical, and technological information into land management to meet desired objectives. Forest and range lands are managed to produce resources and services of many kinds for the American people. Fire, as a natural force, must be considered not only for its potential to do damage but also for its ability to play a needed and beneficial role in many natural ecosystems. Fire control and prescribed burning, therefore, are not automatic actions. They are actions for carefully arrived at, specifically planned purposes. In essence, fire management seeks to place fire in perspective with the overall resource management objectives to meet the many needs of our society. How fire is used will determine whether it is a friend or foe of society and the environment in which that society dwells.

DID YOU KNOW . . . ?

1. Did you know that the firefighter may work long hours--continuous work for 12 or 16 hours is not uncommon in emergency situations.

2. Did you know that some fires, especially large ones, have a professional meteorologist in attendance who sets up fire weather stations and receives forecasts from the National Weather Service?

3. Did you know that a wildland firefighter's backpack may include these items: a flashlight; a hardhat; a one gallon canteen; a first-aid kit; a snakebite kit; a whetstone or file; three meal rations; one sleeping bag; and a fireproof tent.

4. Did you know studies of smokejumper activity in the Northern Rockies show that 90 percent of the fires attacked are controlled (stopped from spreading) within 24 hours?

5. Did you know helicopters can be used to rapidly lay long sections of firehose through the forest and thus bring water to dry areas when needed?

6. Did you know that forest ranger E.C. Pulaski, a relative of Revolutionary War hero Casimir Pulaski, saved 39 firefighters' lives during a 1910 Idaho wildfire? This heroic ranger also invented the Pulaski fire tool--a combination grub hoe and axe.

7. Did you know that highly trained rapelling crews descend down ropes from hovering helicopters to attack fires in remote or rugged areas?

8. Did you know that in 1974 forest and range fire suppression in the United States cost about 325 million dollars?

9. Did you know that in 1935, the U.S. Forest Service experimented in aerial fire control by dropping water and chemical bombs on fires? At that time, the process was discontinued because the limited payload capacity of the small, slow planes made it impractical.

10. Did you know that air tankers can now hold up to 3,000 gallons of chemical fire retardants?

11. Did you know there are an estimated 8 million lightning strikes in the world each day, resulting in about 50,000 wildland fires each year?

12. Did you know that the now widely-accepted practice of prescribed burning for fuelbreaks was first used in the New Jersey Pine Barrens over 45 years ago?

Nature's fireworks. Umpqua National Forest, Oregon. F-413961

Lightning visits the forest leaving its calling card--eight new forest fires. Worldwide, there are an estimated 8 million lightning strikes each day. In the northern Rockies, over 34 percent of the wildfires come from lightning strikes on snags (standing dead trees). These snags are frequently the aftermath of a forest fire or an insect or disease epidemic.

It takes muscle and hand tools, too. Kaniksu National Forest, Idaho. F-517063

Forest Service firefighter with an indispensable dual-purpose Pulaski fire tool designed for both digging and chopping. It was invented by a heroic Forest Ranger whose action saved the lives of 39 firefighters during the disasterous 1910 Idaho forest fire.

13. Did you know that, in the South, wildfires burn less than 10 acres a year for every 10,000 acres on which fire hazard reduction has been accomplished through prescribed burning? Where prescribed burning is not used for fuel reduction wildfires may burn as much as 700 acres a year for every 10,000 acres protected.

14. Did you know that prescribed burning is used in areas of the Everglades National Park to maintain the marsh grass habitat for the threatened Cape Sable seaside sparrow?

15. Did you know that 1970 estimates show that the acreage of preplanned prescribed burned land exceeded that burned by wildfire; 2.5 million acres of land were treated with prescribed fire as compared to only 2.25 million acres burned by wildfire.

16. Did you know that in pine forests, white smoke indicates a surface fire while black smoke is given off when the pitch laden pine trees are burning?

17. Did you know firefighters position burning logs in an uphill-downhill posture to prevent them from rolling down the hill and starting new fires or injuring firefighters who may be working below?

18. Did you know that firelines are constructed upslope so that firefighters are not trapped by fires that cross the slope and sweep up the hill?

19. Did you know that winds blow upvalley during the day and downvalley at night due to differences in local air pressure?

20. Did you know that winds blow upslope when the sun is shining on that slope and downslope at night or when it is cloudy? These winds are the result of surface heating and cooling of the land.

21. Did you know that canyons, mountains, and valleys can cause erratic, turbulent winds and unusual fire behavior?

22. Did you know wind speeds of downdrafts from thunderstorms have been measured at more than 75 mph?

23. Did you know that about 31 percent of all fires occur on the south and southwest slopes of mountains because those slopes are warmer and drier?

24. Did you know that spotfires occurred 10 to 12 miles in advance of the main fire front during the Sundance Fire (Idaho; 1967)?

25. Did you know that the habitat of the bobwhite quail was one of the first wildlife species to be managed through the use of prescribed burning?

26. Did you know that warm, persistent, dry winds called "Chinook Winds" occur on the eastern slopes of the Rocky Mountains and can develop severe fire hazard conditions?

27. Did you know the "Santa Ana Winds," warm, very dry, and often very strong easterly winds in Southern California, can cause very dangerous fire weather conditions in that region?

28. Did you know the total amount of water vapor in the air over North America is estimated to be more than 6 times the water carried by all our rivers?

29. Did you know that during the day it is cooler on mountain tops than in the valleys, but at night, the mountain tops are warmer?

30. Did you know the middle third of a mountain is called the thermal belt because it is usually hotter, drier, and thus has more severe fire conditions than the other parts of a mountain?

31. Did you know that in the Northern Rockies, over 34 percent of the wildfires start from lightning strikes in snags (dead trees)?

32. Did you know that the atmosphere is 300 miles deep but all of our weather occurs in the troposphere, a shallow, 10 mile-deep layer of air covering which blankets the earth?

33. Did you know that of the sun's vast output of energy on the upper atmosphere, less than 50 percent reaches the Earth's surface due to losses from reflection and absorption?

34. Did you know that relative humidity is a measure of atmospheric moisture and varies inversely with temperature?

35. Did you know that pillowy cumulus clouds, good visibility, and gusty winds are indicators of an unstable atmosphere?

36. Did you know that dry thunderstorms of the West are frequent sources of ignition because, although lightning strikes are produced, the rain evaporates before reaching the dry fuels on the ground?

37. Did you know that the fuel-bed temperature in open areas may reach 160 degrees Fahrenheit during sunny days? This reduces the surface fuel moisture content to very low levels.

38. Did you know that the fire climate of a region is the integration, over time, of all the weather elements which affect fire behavior? There are 15 so-called "fire climate regions" in North America.

39. Did you know that the weighing of fuel moisture indicator sticks made of ponderosa pine or basswood is normally used to measure the fuel moisture content of dead fuels in the vicinity of the sticks?

40. Did you know that the Northeastern Indians used to set fire to the woods to create fields in which to grow corn, attract deer, and increase berry production?

41. Did you know that the seedling stage of longleaf pine is called the "grass stage;" at this time the tree is quite resistant to fire damage.

42. Did you know that infrared imagery systems mounted in airplanes can detect small fires and hot spots by day, night, or in fog?

43. Did you know that the Federal government cooperates with State organizations and private forest owners in fire control? Over $147 million was spent in 1974 to protect State and private lands.

44. Did you know that ponderosa pines grow in open, parklike stands where light grass fires are quite common?

45. Did you know that the first U.S. Forest Service fire control policy was formulated in 1905 to protect the National Forests from fires?

46. Did you know that backfires can spread against the wind at speeds varying from 70 to 200 feet per hour?

47. Did you know that damage from wildfire can be greatly reduced by any type of prescribed burning? Less ground fuel produces less heat.

48. Did you know that on the average, because of their huge size, less than one percent of all wildfires each year are responsible for more than 64 percent of the total acreage burned in the nation?

49. Did you know that some grasslands are prescribe-burned to improve the habitat of the prairie chicken by removing dead vegetation and rejuvenating the palatable native grasses?

50. Did you know lightning is just a gigantic spark between the negatively charged lower cloud and the positively charged Earth?

51. Did you know that fuelbreaks are frequently seeded with grasses and used as forage areas for cattle, goats, and wildlife?

52. Did you know that heat from fire serves to open the serotinous cones of jack pine, sand pine, and lodgepole pine, releasing the seeds therein?

53. Did you know the rare Kirtland's warbler of Michigan would be extinct if fire wasn't used in the management of its limited jack pine habitat?

54. Did you know that prescribed fire has been used to decrease the amount of rot in oak sprout stands by forcing sprouts to originate from below the ground line?

55. Did you know that fire stimulates root sprouting in harvested quaking aspen stands, thus ensuring a rapid growing, new well-stocked stand?

56. Did you know that fuelbreaks often attract many wildlife species and provide excellent areas for hiking, hunting, and nature study?

57. Did you know that smokejumpers have made over 120,000 jumps to fight wildfires since 1940?

58. Did you know that many wildland fire retardants subsequently double as plant fertilizers?

59. Did you know that about 90 percent of the longleaf pine forests of the South are prescribe-burned at least once every 3 or 4 years?

60. Did you know that the brownspot needle blight of young longleaf pine is spread by rain which splashes the fungus spores from infected needles on the soil surface onto healthy needles?

61. Did you know that backfires, because they are slower moving and achieve more complete combustion, produce only 1/5 to 1/3 as many polluting particulates as headfires?

62. Did you know that prescribed burning is practiced on Wind Cave National Park, South Dakota, to improve the grasslands for the American bison and elk?

63. Did you know that the CCC built a gigantic 600 mile long fuelbreak in California called the Ponderosa Way?

64. Did you know that the old General Land Office (now incorporated into the Bureau of Land Management) was charged with the duty of protecting the U.S. Forest Reserves from fire in 1897?

Picking the right place to land. Lolo National Forest, Montana.
F-513797

Smokejumping, though hazardous work, can be made safe through thorough training and stringent physical conditioning. Note that the clearing to which these smokejumpers have guided their chutes are well away from the fire. Since 1940, Forest Service smokejumpers have made about 120,000 jumps to wildfires with only one accidental fatality.

Fire hazard reduction. Gifford Pinchot National Forest, Washington. F-402093

The Civilian Conservation Corps (CCC) was a vast reserve of young unemployed men that in the depression 30's, catapulted forest conservation decades into the future. Here they are felling lightning-prone snags in an old burn. In the northern Rockies 34 percent of lightning-caused fires are started by lightning strikes on snags.

65. Did you know that the Wilderness Act of 1964 states that the designated Wilderness Areas must be maintained in their natural state?

66. Did you know that fire, when properly managed, can help maintain or restore the great plant and animal diversity of some of our Wilderness Areas?

67. Did you know that the best paper birch stands almost always occur on burned or cutover land? In this case fire functions as a seed bed preparer.

68. Did you know that prescribed fire has been successfully used in yellow-poplar site preparation when there are heavy accumulations of forest litter present?

69. Did you know that prescribed fire gives off 5 to 27 lbs. of hydrocarbons per ton of fuel burned while automobiles emit 130 lbs. per ton of gasoline burned?

70. Did you know that about 11,000 people are employed by State organizations in wildfire control activities?

71. Did you know that "smoke chasing" is the act of quickly finding reported fires and starting the initial attack?

72. Did you know that about one ton of fuel per acre is needed to support a small fire?

73. Did you know that the U.S. Army was the first agency to have an organized fire control program? It was practiced during the early 1890's when the Army was responsible for protecting Yellowstone National Park.

74. Did you know that the Northeastern Forest Fire Protection Commission, providing for Interstate sharing of men and equipment in fire emergencies and organized in 1949, was the first interstate cooperative fire control agreement between States in the Nation?

75. Did you know that each year, the Federal General Services Administration furnishes about $15 million worth of surplus fire suppression equipment to public fire protection agencies?

76. Did you know that experiments in lodgepole pine stands indicate that, by employing complete utilization logging techniques, the fire hazard can be reduced to tolerable levels?

77. Did you know that a test fire is used before starting a prescribed fire to determine the exact burning conditions and fire behavior?

78. Did you know that prescribed burning is practiced on Isle Royale National Park in Lake Superior to improve the habitat for moose?

79. Did you know that in Southern California, critical fire weather can occur year round?

80. Did you know that the fire season in Alaska usually starts in May, after the winter snow melts, and lasts until September?

81. Did you know that the average maximum practical visibility distance from a fire lookout tower is normally about 15 miles in the West and 6 miles in the East?

82. Did you know that even though the average number of wildfires in the U.S. has been increasing during the last several years, the total acreage burned, due to prompt suppression, is decreasing?

83. Did you know that 89 percent of all wildfires are on State and private lands?

84. Did you know that incendiarism, which is on the rise, is the leading cause of wildfires in America?

85. Did you know that forests moderate the temperature, humidity, and wind speeds beneath the forest canopy?

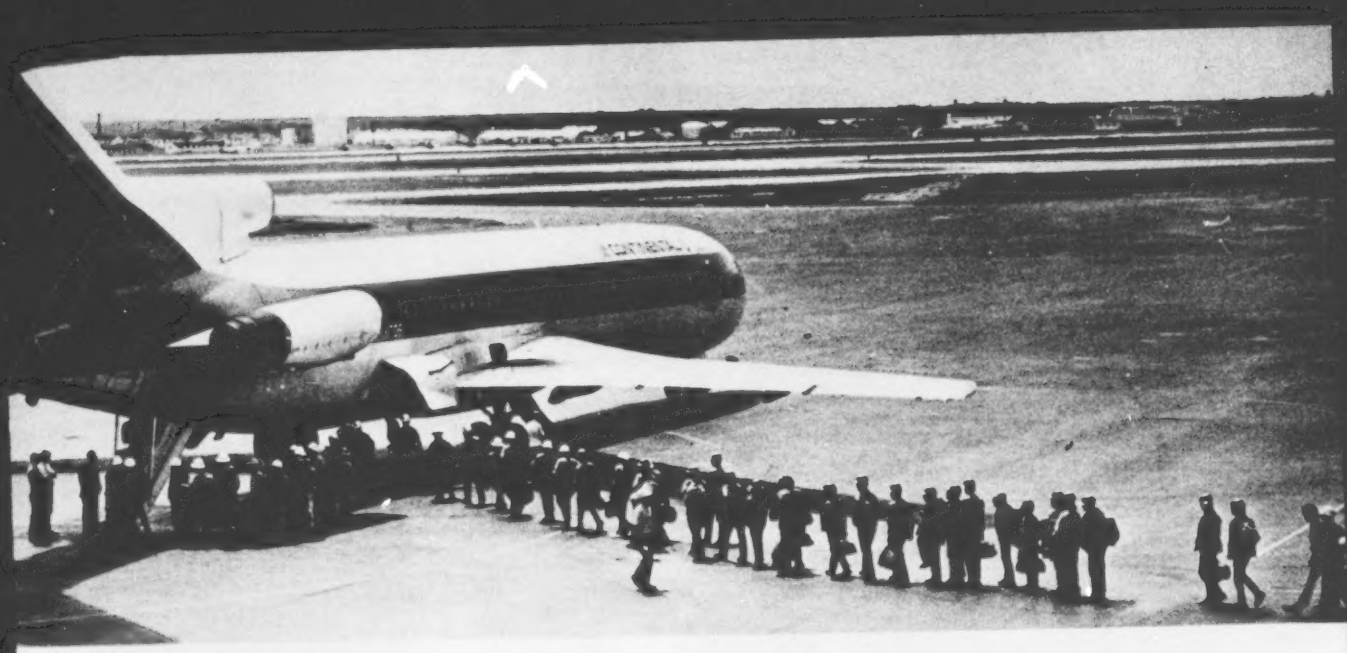
86. Did you know that the disasterous October 1947 wildfires in Maine burned 250 thousand acres and caused a property loss of about $32 million?

87. Did you know that the Entiat, Washington, wildfires of 1970 burned over 49,000 acres and cost over $4 million to fight?

88. Did you know that fire simulator teaching concepts are now being used in many areas of land use planning?

89. Did you know that on the Cleveland National Forest, California, the Forest Service is introducing herds of browsing domestic goats as a way of keeping invading brush growth from taking over cleared firebreaks?

90. Did you know that 9 out of 10 forest fires in America are caused by humans?



Total mobility. Boise (Idaho) Interagency Fire Center Airport. BLM photo

Experienced, well-equipped firefighters board a charter flight headed for a large distant fire. The Center was established in 1970 by five Federal land managing agencies and the States to share their firefighting capabilities in emergencies. It is jointly staffed, equipped and financed by the agencies. (See page 23.)

Please be careful. Superior National Forest, Minnesota. F-503655

Roadside fire prevention sign on Highway No. 1 near the Isabella Ranger Station. During the forest fire season this sign is maintained daily to keep motorists and forest users advised of the current fire danger. Note that on the day of the photo the fire danger was "medium" with a plea to "be careful, it can get dry." Similar signs are displayed in many other parts of the nation during forest fire seasons.

91. Did you know it is unlawful in many states to build a fire in forest lands without a permit except in designated areas?

92. Did you know that the technology exists to virtually eliminate the approximate 6,000 fires that annually occur along railroad rights of way from exhaust and brake systems on trains?

93. Did you know that almost 6 out of 8 man-caused fires occur in the eastern and southern states?

94. Did you know Smokey Bear, as a fire prevention symbol, was created in 1945?

95. Did you know that if a child writes to Smokey Bear, Washington, D.C. 20252, she or he will receive a Junior Forest Ranger kit?

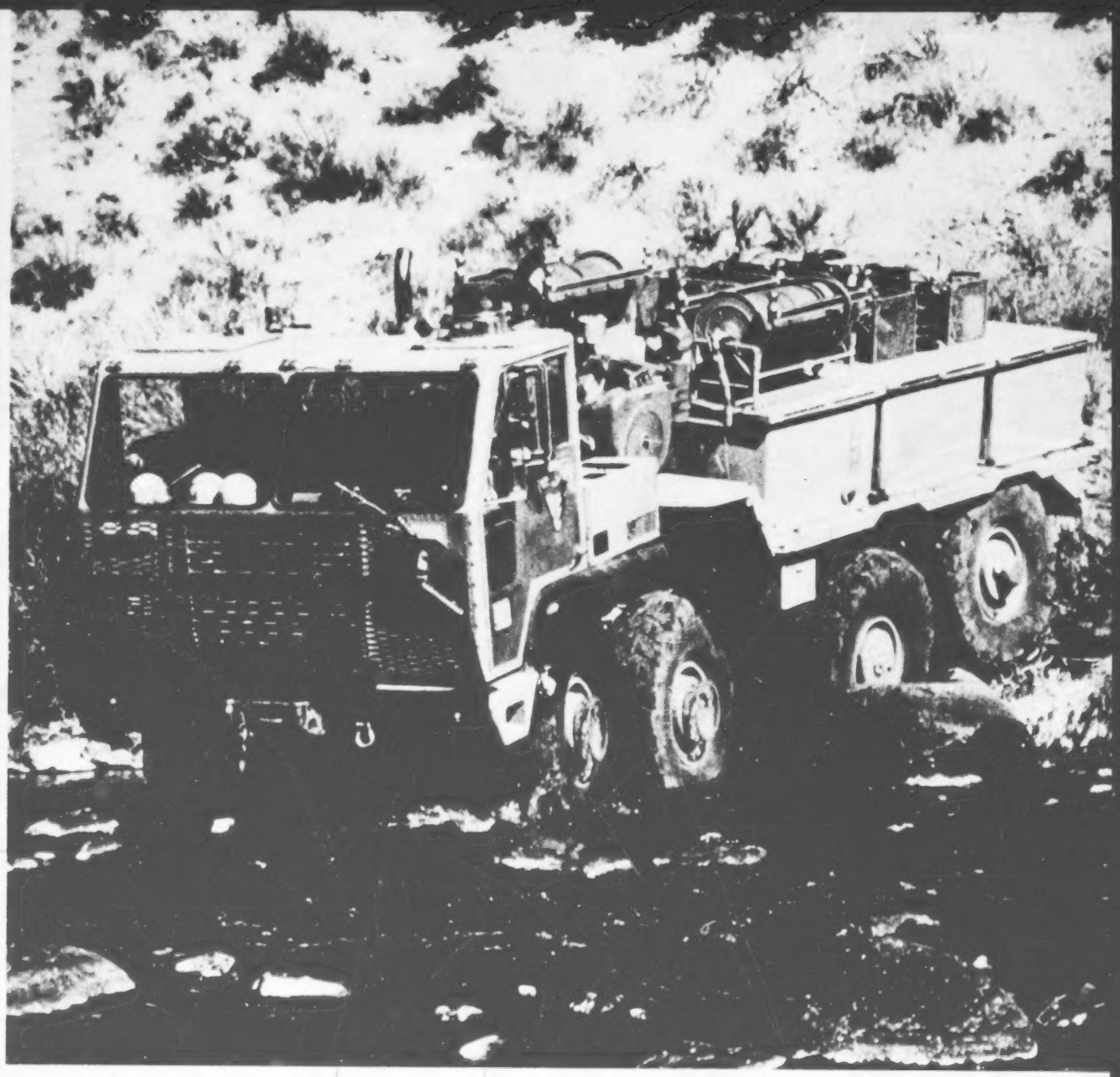
96. Did you know that Savings Bonds and Smokey Bear are the two oldest and among the most successful public service campaigns conducted by the Advertising Council?

97. Did you know that a live bear symbol of the Smokey Bear program resides in the National Zoo in Washington, D.C.?

98. Did you know that the unauthorized commercial use of the name and character of Smokey Bear is prohibited by a Federal law?

99. Did you know that man-caused forest fires are chiefly the result of children playing with matches, debris burning, escaped campfires, smoking and incendiarism?

77



"Dragon Wagon." Something new in the firefighter's suppression kit. BLM photo.

This is a highly versatile self-contained surface access vehicle designed for rapid response and closer approach to wildfires. Now under test in the West where it is particularly suitable for use on 130 million acres of Bureau of Land Management lands, 30 million acres of National Forests, and other western lands.

TWISTER DRAGON WAGON

For decades firefighters in rough terrain have been frustrated and delayed by motoring some miles toward a fire and then having to walk and carry their tools and equipment the rest of the way when the going became too rough for their vehicles. The net result has been tired men, delayed initial attack, larger fires and tiring hand tools to work with. Then, just recently, came the "Twister Dragon Wagon"--about one hundred years after the early horse and mule days of America's forestry pioneer, Dr. Franklin B. Hough.

Experimental in nature, the "Dragon Wagon" is a "complete firefighting machine." Designed for and being tested by the Bureau of Land Management (BLM), this machine can hurry to a fire along a highway at up to 56 miles per hour. Its unique two-body design, walking beam suspension and 8-wheel drive takes it over terrain that would turn back a conventional vehicle and assures constant contact [illegible] 11 wheels for steady driving power.

It can climb slopes up to 60 percent and is at home on desert sand, alkali mud, rice paddy bogs, shale and rocky areas and on snow. It can ford wet muddy terrain in depths up to 45 inches. Chiefly designed for off-road use, its huge soft radial tires assure practically no disturbance of soil and vegetation. It is a highly sophisticated firefighting "package." The "Dragon Wagon" can lay down chemical fire retardants, spray water and backfire mechanically. It is equipped with hose, pumps, tanks, radio communication, an 850 gallon water tank, a 200 gallon liquid concentrate fire retardant tank, and other features.

The "Dragon Wagon" was designed and built to BLM specifications by a noted aircraft manufacturer. The Bureau is putting it through extensive, rigorous testing under a wide range of actual field conditions. Although it is too early to predict its eventual future, it has already made a promising debut and is being eagerly watched by wildland fire protection organizations throughout the United States and Canada.

Backpacker. Sawtooth National Forest, Idaho. F-509898

Like a tree, a deer, a lake or a mountain, man is an integral part of nature and its ecological makeup. Fire, depending upon how it is managed, can enhance or retard this vital relationship.

WE, TOO, ARE WORKING RESIDENTS OF THE FOREST AND RANGE. THANKS FOR KEEPING OUR HOME GREEN.

(Burro with day old colt. Willamette National Forest, Oregon. F 401927)

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ABOUT THE FOREST SERVICE . . . . .

As our Nation grows, people expect and need more from their forests--more wood; more water, fish and wildlife; more recreation and natural beauty; more special forest products and forage. The Forest Service of the U.S. Department of Agriculture helps to fulfill these expectations and needs through three major activities:

> Conducting forest and range research at over 75 U.S. locations, including Puerto Rico, Alaska, and Hawaii.
>
> Participating with all 50 State forestry agencies in cooperative programs to protect, improve, and prudently use our Country's 772 million acres of State, local, and private commercial and non-commercial forest lands.
>
> Managing, protecting, and directing the use of the 187 million acre National Forest System.

The Forest Service does this by encouraging use of the new knowledge that research scientists develop; by setting an example in managing, under sustained yield, the National Forests and Grasslands for multiple use purposes; and by cooperating with all States and with private citizens in their efforts to achieve better management, protection, and use of forest resources.

Traditionally, Forest Service people have been active members of the communities and towns in which they live and work. They strive to secure for all, continuous benefits from the Country's forest resources.

For more than 70 years, the Forest Service has been serving the Nation as a leading natural resource conservation agency.